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salamanders with relatively short, pointed snouts and stout tails (Martof and Gerhart, 1965; Palis, 1996; Palis, unpublished data).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from 4.5 to 11 grams (adult males and adult gravid [containing mature eggs] females), respectively (Palis, 1996; Palis, unpublished data).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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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).

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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 Outlying 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

Reclassification Criteria:
Recovery Priority Number: 2

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

Juvenile: 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).

Recovery Priority Number: 6C

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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References

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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

Larvae: 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: Aquatic/Terrestrial

Adult: Aquatic/Terrestrial

Habitat Vegetation or Surface Water Classification

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

Habitat Narrative

Larvae: Some larvae metamorphose into immature terrestrial morphs, subsequently developing outside of the aquatic habitat as mature terrestrial morphs (Collins et al. 1988). Alternatively, most larvae remain in the aquatic habitat and develop into paedomorphic gilled adults (USFWS, 2024).

Adult: Sonoran tiger salamanders are endemic to the Santa Cruz and San Pedro River drainages in the San Rafael Valley and surrounding foothills of the Patagonia and Huachuca Mountains in Arizona (Service 2002). Populations of this subspecies may also occur in Sonora, Mexico (Hossack et al. 2016a, 2021). Historically, the Sonoran tiger salamander likely inhabited springs, ciénegas, vernal pools, backwater marshes of the Santa Cruz River, and streams in the San Rafael Valley where permanent or nearly permanent water allowed survival of mature branchiates. Because of the loss of these natural habitats, Sonoran tiger salamanders currently rely almost exclusively on artificial livestock tanks for aquatic breeding sites (Service 2002, Hossack et al. 2016b, Brocka et al. 2024). As many as 300 stock tanks may occur within the range of the Sonoran tiger salamander (Service 2007). As of the previous 5-year review, the subspecies had been documented at 37 of 139 stock tanks sampled (Service 2007). Subsequently, the subspecies has been documented from at least 81 unique sites, although not all of these sites are concurrently occupied (Hossack et al. 2016b). Periodic drying of the stock tanks results in fluctuating numbers and locations of extant populations of the subspecies (Hossack et al. 2017). During a monitoring program conducted by the Arizona Game and Fish Department from 2004 to 2013, Sonoran tiger salamanders were found at 67 of 156 stock tanks surveyed, each of which was sampled for one to eight years (Hossack et al. 2016b, Hossack et al. 2017). Mean annual occupancy of salamanders at wet sites was 59.2%, with only 9.2% of dry ponds estimated to have been occupied at some time during the same season (Hossack et al. 2017). Estimated occupancy of Sonoran tiger salamanders increased by 2.2% per year during the 10-year study (Hossack et al. 2016b). However, the increase in occupancy coincided with a 2% annual increase in the proportion of ponds that contained water when surveyed (Hossack et al. 2016b). This increase in ponds that contained water when surveyed likely explains part of the trend in salamander occupancy (Hossack et al. 2016b). At these same sites, mean annual occupancy of invasive aquatic predators was 34.9% and did not significantly change during the 10-year study (USFWS, 2024).

Dispersal/Migration

Motility/Mobility

Larvae: Unknown

Adult: Low

Dispersal

Adult: Moderate (USFWS, 2024)

Dispersal/Migration Narrative

Adult: Since the previous 5-year review, new information is available regarding movements, home ranges, and survivorship of terrestrial morph Sonoran tiger salamanders. Brocka et al. (2024) implanted radio-transmitters in 78 terrestrial adult Sonoran tiger salamanders and tracked these individuals for an average of 190 days. Mean total traveled distance was 751.5 meters (m) (± 353.8 m), mean maximum distance moved was 403.6 m (± 215.2 m) and mean daily distance was 4.52 m (± 2.30 m). One salamander traveled a maximum distance of 974 m from the tank edge, but none of the implanted salamanders traveled to a different stock tank (any tank on the landscape) during their tracking period (Brocka et al. 2024). Home ranges estimated for 11 salamanders with sufficient data exhibited high individual variability (mean home range: 3,054 square meters [m2] ± 4,301 m2). Salamanders were located most often within small mammal burrows (96%) followed by leaf litter (2%), tree stumps (2%), and rock ledges (<1%) (Brocka et al. 2024). Of a subset of 58 salamanders used for survivorship analysis, the mortality rate was 81%. The most common cause of mortality was predation (44.8%) followed by desiccation (22.4%). Despite thick grasscover, Brocka et al. (2024), observed three desiccated salamanders that were not tagged and included in their study, suggesting that desiccation may be common in the San Rafael Valley. Survivorship was higher for salamanders that dispersed to terrestrial habitats during the summer monsoon season than those that dispersed during spring (USFWS, 2024)

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:

81 unique sites, although not all of these sites are concurrently occupied (USFWS, 2024)

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).   As many as 300 stock tanks may occur within the range of the Sonoran tiger salamander (Service 2007). As of the previous 5-year review, the subspecies had been documented at 37 of 139 stock tanks sampled (Service 2007). Subsequently, the subspecies has been documented from at least 81 unique sites, although not all of these sites are concurrently occupied (Hossack et al. 2016b). Periodic drying of the stock tanks results in fluctuating numbers and locations of extant populations of the subspecies (Hossack et al. 2017). During a monitoring program conducted by the Arizona Game and Fish Department from 2004 to 2013, Sonoran tiger salamanders were found at 67 of 156 stock tanks surveyed, each of which was sampled for one to eight years (Hossack et al. 2016b, Hossack et al. 2017). Mean annual occupancy of salamanders at wet sites was 59.2%, with only 9.2% of dry ponds estimated to have been occupied at some time during the same season (Hossack et al. 2017). Estimated occupancy of Sonoran tiger salamanders increased by 2.2% per year during the 10-year study (Hossack et al. 2016b). However, the increase in occupancy coincided with a 2% annual increase in the proportion of ponds that contained water when surveyed (Hossack et al. 2016b). This increase in ponds that contained water when surveyed likely explains part of the trend in salamander occupancy (Hossack et al. 2016b). At these same sites, mean annual occupancy of invasive aquatic predators was 34.9% and did not significantly change during the 10-year study (USFWS, 2024).

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).

Recovery Priority Number: 3

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.

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The 2002 recovery plan (Service 2002) and previous 5-year review (Service 2007) remain the appropriate guiding documents for recommended future actions. A substantial impediment to recovery remains the lack of funds to implement recovery actions. However, we recommend several actions to address data needs for the Sonoran tiger salamander and to improve long-term management decisions for the subspecies. 1. Continue and expand monitoring of Sonoran tiger salamander populations in order to quantitatively estimate the long-term population viability of the subspecies. 2. Continue to support genomic research that evaluates the geographic extent and possible effects of hybridization between Sonoran tiger salamanders and barred tiger salamanders. 3. Support field survey and genomic research efforts to confirm the taxonomic classification of Ambystoma populations in Sonora, Mexico. 4. As recommended in the previous 5-year review, evaluate the efficacy of eliminating mixed and hybrid populations of Sonoran tiger salamanders and barred tiger salamanders to reduce the threat of genetic swamping. 5. Evaluate the feasibility and efficacy of artificially repopulating unoccupied stock tanks or translocating salamanders among tanks to enhance gene flow and therefore genetic diversity of the subspecies. 6. Support research that identifies characteristics of upland habitats that contribute to enhanced survivorship of dispersing terrestrial Sonoran tiger salamanders, including successful dispersal among stock tanks. This information may better inform the potential need for establishing specific buffer widths and habitat conditions adjacent to stock tanks, as well as habitat characteristics that enhance connectivity among stock tanks (USFWS, 2024).

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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 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: *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: Desert slender salamander habitat at known occurrences within Hidden Palm Canyon and Guadalupe Canyon include historically mesic areas, with water supplied by groundwater seepage or seasonal surface water, that supports the persistence of amphibians within an otherwise dry desert environment. Like other Batrachoseps species, the desert slender salamander is fully terrestrial and though they require a moist environment, they do not rely on surface water for reproduction (Jockusch et al. 2020, p. 25). This trait has likely facilitated its persistence in its historical range. Water is supplied to Hidden Palm Canyon from an estimated 440 acres [ac; 178 hectares (ha)] subterranean watershed, which reaches the canyon as groundwater seepage (Service 1982, p. 6). At Guadalupe Canyon, the Martinez and Sheep Mountains drain into the northeast flowing Guadalupe Creek as seasonal surface water and perennial groundwater seepage (Duncan and Esque 1986, pp. 2, 6). At Guadalupe Canyon, the majority of salamanders have been found in organic soils (Duncan and Esque 1986, p. 15). The surface material surrounding Hidden Palm Canyon is exposed bedrock, talus, and coarse-grained sand (Service 1982, pp. 6–7). Rather than soil, porous limestone that covers portions of the canyon wall represents the most important structural habitat component at Hidden Palm Canyon (Service 1982, p. 9). In both cases, desert slender salamanders rely on substrates that retain moisture when other retreats dry out. The geographic isolation of the two occurrences prevents direct disturbance from outdoor recreation or land development. However, this also makes it difficult to access the sites, so relatively little information has been gained about the status and habitat integrity of these sites over the years since listing. USGS scientists conducted surveys from 2017 to 2023 and reported that habitat at Hidden Palm Canyon and Guadalupe Canyon appeared much drier than how it was previously described in the 1980s and 1990s, when desert slender salamander was last detected (Backlin and Fisher 2024, pers. comm.). The reason for these drier conditions is uncertain though it may be attributed to climate change and/or geological changes that have reduced the availability of groundwater. A 1985–1986 study of the desert slender salamander occurrence at Guadalupe Canyon emphasized the association of desert slender salamander with broad-leafed plants that create rich soil, retain moisture, and support arthropods (Duncan and Esque 1986, pp. 34–35). The current conditions at the historical localities are drier than when salamanders were last detected, and it is uncertain if the habitat remains suitable. USGS surveyed for desert slender salamander beyond its known range. Important features for identifying potentially suitable habitat for surveys included rock features that reach the bottom of a canyon and the presence of north facing slopes (Backlin and Fisher 2024, pers. comm.). Further research and survey efforts are needed to identify and confirm suitable habitat for desert slender salamander. (USFWS, 2025)

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:

Species has not been observed since 1997.

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). At the time of listing, Batrachoseps major aridus was known from only one occurrence in Hidden Palm Canyon, estimated to be less than 1 ac (0.4 ha) in size (Service 1982, p. 3). In 1981, an additional occurrence was found in Guadalupe Canyon and confirmed to be the desert slender salamander (Giuliani 1981, pp. 1–17; Brame 1981, pers. comm.). At Guadalupe Canyon, desert slender salamanders were found in small, disjunct patches of habitat that totaled approximately 0.5 ac (0.2 ha), with potential habitat estimated to be 1.5 ac (0.6 ha) (Duncan and Esque 1986, p. 36). No abundance data has been collected in Guadalupe Canyon since a 1984–1985 study, which detected 30 salamanders over 15 nights of sampling (Duncan and Esque 1986, pp. 6, 22). The last detailed study of desert slender salamander at Hidden Palm Canyon occurred in 1977 and 1978 (Bleich 1978, entire). Surveys were conducted four times per month for one year. Typically, 0 to 10 salamanders were found per 100 minutes of survey effort (Bleich 1978, Tables 1–13). Based on length, a large proportion of salamanders detected were juveniles, indicating that the population was reproducing (Bleich 1978, p. 8). Bleich estimated that the population of desert slender salamander at Hidden Palm Canyon was between 133 and 515 individuals (Bleich 1978, p. 9). Desert slender salamanders have not been seen in Hidden Palm Canyon since 1997 (Nicol 1997, p. 1), although biologists from CDFW performed nearly annual searches for desert slender salamander until 2006 (Konno 2013, pers. comm.). USGS performed diurnal and nocturnal visual encounter surveys from 2017 to 2019. Six nocturnal and diurnal surveys were conducted at Hidden Palm Canyon, and one diurnal survey was conducted at Guadalupe Canyon (USGS 2019, p. 1). No desert slender salamanders were found during these surveys. In 2021 and 2023, USGS conducted additional surveys at the two historical occurrences, Hidden Palm Canyon and Guadalupe Canyon, though no salamanders were detected. Surveys were also conducted beyond the known range to encompass the desert regions of Riverside, San Diego, and Imperial Counties, California. The search area expanded beyond previously known habitat in order to evaluate other areas with potentially suitable habitat and discover additional populations. Surveys were conducted at 137 sites across southern California deserts. They found 60 Batrachoseps individuals across 26 sites, including sites in the Santa Rosa Mountains and Anza-Borrego Desert. (USFWS, 2025).

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).

Stressor: Climate Change (USFWS, 2025)
Exposure:
Response:
Consequence:
Narrative: Climate Change Projections The 2014 5-year review identified climate change as a threat to desert slender salamander. In 2014, we generally predicted that the southwest United States would become drier, and that extreme events such as heavier storms, heat waves, and regional droughts would become more common (Glick et al. 2011, p. 7; Service 2014, p. 29). We also predicted that mean annual temperatures in the Sonoran Desert ecoregion, where desert slender salamander occurs, was expected to increase by 1.8 to 2.4°Celsius [C; 3.2 to 4.3°Fahrenheit (F)] (PRBO 2011, p. 47) and that the number of extremely hot days (above the 95th percentile) was expected to increase by 22 days (Bell et al. 2004, pp. 83–85; Service 2014, p. 29). Boyd Deep Canyon Desert Research Center, University of California Riverside, manages a reserve close to Hidden Palm Canyon and has collected continuous weather data since 1974. We used data from the Agave Hill weather station, located at an elevation similar to Hidden Palm Canyon, to understand the trends in temperature around desert slender salamander occurrences. The average maximum temperature in January is 15.9°C (60.6°F), and the average maximum temperature in July is 35.2°C (95.3°F), with an average increase of 0.04°C (0.07°F) per month for both January and July temperatures (Figure 2). Average maximum temperatures in January and July have increased since 1974 and may be contributing to drier habitat. We used data from the Pinyon Crest weather station, located in the recharge area for the seep at Hidden Palm Canyon, to understand trends in annual rainfall around desert slender salamander occurrences. Annual average rainfall is around 23.8 cm (9.4 in) (Figure 3). We relied on data from Cal-Adapt, which used peer-reviewed climate data to build tools to forecast climate change in California (Cal-Adapt 2024). Since desert slender salamander is highly localized, we used Localized Constructed Analogues (LOCA) grid cells as the unit of analysis. In the area around Hidden Palm Canyon, average temperatures are expected to increase, while average precipitation is expected to increase slightly. Annual average maximum temperature is expected to increase, from a baseline of 24.1°C to 26.4°C (75.4°F to 79.6°F) in the mid-century and 27.2°C (81.0°F) in late century, under RCP4.5 medium emissions scenario (Table 4; Cal-Adapt 2024). Annual average precipitation is expected to increase from a baseline of 10.9 inches to 12.3 inches in the mid-century and 11.7 inches in late century (Table 5; Cal-Adapt 2024). (USFWS, 2025)

Stressor: Groundwater Pumping (USFWS, 2025)
Exposure:
Response:
Consequence:
Narrative: The 2014 and 2020 5-year reviews describe the threat of increased groundwater pumping in the upper watershed (Service 2014, pp. 19–20; Service 2020, p. 2). While both historical localities are geographically remote with no anticipated threat of development, the

habitats may be 2025 5-year Review for Desert Slender Salamander indirectly impacted by groundwater pumping of the surrounding watershed. Since Guadalupe Canyon is located within the Santa Rosa Wilderness Area, prohibiting any development in the area, groundwater pumping is only considered a threat for Hidden Palm Canyon. The uphill watershed of Hidden Palm Canyon is the site of approximately 50 homes that appear to have been constructed decades ago. There has been limited development in this area for the past 15 years, with the construction of less than five houses, and no additional development since 2013 (Service 2024b, GIS data). The estimated water usage of this limited number of homes is expected to be low given the size of the watershed (Service 2014, p. 19). Based on the limited development in the Hidden Palm Canyon watershed, groundwater pumping is considered a low magnitude threat. (USFWS, 2025)

Stressor: Fire (USFWS, 2025)
Exposure:
Response:
Consequence:
Narrative: The 2014 and 2020 5-year reviews identified fire as a threat to the habitat of desert slender salamander. Fire is unlikely to be a source of direct mortality for desert slender salamander because the hot, dry conditions associated with increased fire probability induce the salamanders to retreat underground. The 2014 5-year review concludes that the greatest threat that fire would be associated with is post-fire erosion effects, such as a precipitation event following a wildfire that could lead to debris flows. Though there have been no recent fires in Hidden Palm Canyon or Guadalupe Canyon, there have been four small fires in the watershed areas around the two historical localities within the past 15 years (Cal-Fire 2022, Fire Perimeters). According to the CalFire Fire Probability for Carbon Accounting map, which estimates the projected annual probability of wildfire from 2021–2050, Guadalupe Canyon is mostly located in a 0.4-0.5 percent fire probability risk, while Hidden Palm Canyon has a <0.25 percent fire probability risk (CalFire 2024, Fire Probability). These data and estimates correspond with characterizations of vegetation around desert slender salamander habitat. The watershed and adjacent slopes surrounding desert slender salamander habitat are drier and dominated by desert vegetation (Brame 1970, p. 7; Bleich 1978, p. 3; Service 1982, p. 7). The fire return interval for the vegetation association in this area (Agave deserti Shrubland Alliance) is characterized as truncated and long, with typically low intensity and moderate severity fires (Sawyer et al. 2009, p. 334). The natural intensity and severity of fire in the Washingtonia filifera Woodland Alliance found within the canyons is low (Sawyer et al. 2009, p. 300). Except for the effect nonnative grasses might have on fire frequency, the composition of the plant community in the surrounding watershed suggests that a fire is unlikely to be carried through this area (Fisher 2013, pers. comm.). Therefore, the risk of fire in the canyon itself appears low. Knowledge of amphibian responses to wildfire is limited compared to other vertebrates. In a 2011 review, Hossack and Pilliod (p. 131) conclude that direct mortality from fire is a small threat to most healthy populations, although fire, or any stochastic stressor, could pose a more severe threat to small, isolated populations such as the desert slender salamander. Additionally, wildfires may produce cryptic effects in salamanders such as host-specific changes in skin microbiota (Mulla and Hernandez-Gomez 2023, p. 2203). However, the subterranean association of desert slender salamander combined with the low intensity, severity, and probability of fire in the habitat makes direct mortality from fire a low magnitude threat. Although fire itself does not pose an immediate or severe threat to desert slender salamander, the compounding post-fire effects could greatly disturb its habitat. A fire on the slopes of the canyon followed by a rain event could facilitate habitat degradation from debris flows. Post-fire debris flows have reduced amphibian

habitat and nearly extirpated endangered populations in Southern California (Service 2009, p. 9; Backlin et al. 2013, p. 162). Although debris flows in the drier desert climate will not likely be as destructive as debris flows that affect mountain habitats with greater vegetative cover and greater precipitation, debris flows have the potential to bury the limited amount of suitable habitat available to desert slender salamander. The threat of fire, rain events, and potential debris flows should continue to be monitored with changing climactic conditions (USFWS, 2025)

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).

Recovery Priority Number: 6

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).
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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)
- RECOMMENDATIONS FOR FUTURE ACTIONS We recommend that the following actions be completed over the next 5 years to manage threats to Batrachoseps major aridus and aid in recovery efforts. We recognize that conservation of this species will require cooperation and

coordination with partners. 1. Conduct additional surveys at Hidden Palm Canyon and Guadalupe Canyon to determine whether the habitat is suitable, and the populations remains extant. 2. Continue surveys at potentially suitable habitat in Santa Rosa Mountains and other areas in Southern California. 3. Fill knowledge gaps related to species life history, ecology, and habitat needs. Specifically, determine when and how often desert slender salamander must surface from subterranean spaces to inform more effective survey techniques and understand threats. 4. Conduct genomic analysis of Batrachoseps individuals detected in Santa Rosa Mountains to confirm whether they represent a new occurrence for the species. 5. Evaluate impacts of climate change through drought and extreme precipitation events on habitat suitability. 6. Continue to monitor for Batrachochytrium dendrobatidis (Bd) and Batrachochytrium salamandrivorans (Bsal) within the species range. (USFWS, 2025)

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). Griffith League Ranch (GLR), in Bastrop County, Texas, is currently the only area with a large enough Houston toad population, land access, and repeat successful survey efforts to analyze population and demographic trends. Survey methods on the GLR include human surveys of calling toads and trapping toads for blood and tissue samples. The yearly average of male toad detections on the GLR was 76 detections from 2001-2023, with negative bias during the years 2012-2015 due to the 2011 Bastrop County fire (Duarte et al. 2014, p. 365). Surveys in 2023 found over 710 wild male Houston toad detections on the GLR (Forstner 2023, p. 1-3). Data to inform population estimates outside of the GLR is lacking and precludes reliable population estimation of Houston toad populations at other sites across its range. Through the Houston toad captive breeding program, egg strands have been bred in captivity at the Houston Zoo, Fort Worth Zoo, Dallas Zoo, and the San Marcos Aquatic Resources Center and released yearly in ponds at the GLR to maintain a steady and increasing population. From 2018-2023 between 650,000 – 2, 100,000 eggs were released each year (Dallas Zoo 2018-2023, Houston Zoo 2018-2023, Fort Worth 2018-2023). The headstarting program has been implemented since 2007, resulting in maturation of captive-bred eggs to reproductive adult toads at these facilities. Wild toads and the toads initially bred in captivity are reproductive with each other, thus creating subsequent generations of toads with zero, one, or both parents from a captive breeding facility. Wild egg strands have been observed in the GLR ponds, with 46 wild egg strands in 2022, and 67 egg strands in 2023 (Forstner 2022, p. 1-3, Forster 2023, pp. 1-3) (USFWS, 2024).

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.

Stressor: Roadways (USFWS, 2024)
Exposure:
Response:
Consequence:

Narrative: Roadways can heavily impact Houston toads through direct mortality from vehicle strikes, reducing the overall available habitat and native vegetation, reducing the quality of surrounding habitat; impacts of roadway impervious cover including increased surface temperatures and runoff, and fragmenting the landscape. (Reh and Seitz 1990, pp. 247). Roads can create a barrier effect to toad movement and increase habitat fragmentation when individuals are killed on the road, the surrounding habitat quality is reduced, or toads behaviorally avoid the road. (Fahrig et al. 2004, p. 177-182, Jochimsen et al. 2004, p. 31). Amphibians may have higher vulnerability of impacts by vehicle strikes when compared to other taxa due to their tendency to migrate en masse near water sources or breeding ponds (Glista et al. 2007, p. 77). This increased vulnerability to road strikes is consistent with the metapopulation dynamics and explosive breeding at ponds by Houston toads. The total length of roads and the traffic density on roads have both increased within the Houston toad recovery units from 2018 to 2022, the last year currently available (Table 4. TXDoT 2024). The total length of public roads present within the recovery units increased 51.65 miles between 2018 and 2022. Traffic density is measure by the annual average daily traffic on public roads, monitored by TXDoT cameras. I used the road lengths and annual average daily traffic to calculate the total vehicle miles traveled (VMT). The VMT increased each year from 2018-2023, except for a decline in 2020, which can be attributed to the pandemic, when overall vehicle use was greatly reduced (Figure 3). Overall, the annual average daily traffic on public roads increased 12.5% between 2018 and 2022 (USFWS, 2024)

Stressor: Climate Change (USFWS, 2024)
Exposure:
Response:
Consequence:
Narrative: Climate change and projected increased drought severity and frequency is a substantial threat to the Houston toad. Temperature in Texas is projected to continue increasing at or greater than the global average rate of increase, especially during droughts (Chiang et al., 2018, pp. 1-4). Precipitation intensity and variability is anticipated to increase, but models do not all agree on the magnitude and directionality of projected precipitation change (Easterling et al. 2017, pp. 223-225). However, predictions trend towards an overall decrease in precipitation (Nielsen-Gammon et al. 2020, p. 5). The Bastrop Complex Fire occurred in 2011, with 64 days having a maximum temperature above 37.8° Celsius (°C) (100° Fahrenheit (°F)). With increased annual daily temperatures and increased number of days with a maximum temperature greater than 37.8°C (100°F), there will likely be increased drought, higher probability of catastrophic fire, and decreased surface water and moisture available (USFWS 2022, p.13). Dryer and hotter conditions could result in less successful breeding, recruitment, and reduced dispersal. Recent summers have been shown recordbreaking temperatures, during which we have also seen a decline in the number of detected sites (USFWS, 2024)

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)

Recovery Priority Number: 2C

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)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Acquisition and protection of lands within the six management units is the most critical recovery action for the Houston toad o Continued implementation and expansion of programs such as conservation banks is needed Continuation and expansion of the captive propagation and supplementation program o Identify additional reintroduction sites, especially in other management units apart from the GLR o Revise approaches to propagation and supplementation spatially by genetically differentiated management units Private landowner outreach o Host additional landowner education workshops targeted strategically in areas of high conservation need Monitoring program o Expand monitoring distribution and effort across species range o Increase area available for monitoring by working with private landowners Research o Research is needed to better understand how adult and juvenile toads use open habitat types o Assess efficacy of habitat restoration techniques, and adjust as needed o Additional research topics include juvenile movement and dispersal, adult toad home range size, population viability analysis, resistance to dispersal and movement through varying habitat types, species distribution modelling, connectivity analyses, and veterinary research at captive facilities Effective Planning and Communication o Coordinate and plan with partners, track recovery and implementation progress, and implement adaptive management (USFWS, 2024).

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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). The Georgetown, Salado, and Jollyville Plateau salamanders are endemic to the northern segment of the Edwards Aquifer in Bell, Travis, and Williamson counties, Texas (Figures 1 and 2 below; Devitt et al. 2019, p. 2629). Genetic research conducted since the species listing assessed population structure, phylogeny, and distribution of multiple Eurycea species across central to west-central Texas (Devitt et al. 2019, entire). The results of that work had substantial taxonomic and distributional implications for several of the region's Eurycea species, including the Georgetown and Salado salamanders. Salamanders from the Berry Creek watershed, formerly assigned to the Georgetown salamander, were noted to be genetically similar to the Salado salamander and assigned to the latter species (Devitt et al. 2019, p. 2629). This reassignment of populations expanded the range of the Salado salamander to the south into Williamson County and reduced the range of the Georgetown salamander to sites south and east of Lake Georgetown in the watersheds of the North and Middle Forks of the San Gabriel River (Devitt et al. 2019, p. 2629). A single salamander collected from San Gabriel Springs, long considered the Georgetown salamander, was found to be more genetically similar to the Jollyville Plateau salamander and assigned to that Eurycea species (USFWS, 2024).

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:

Increasing (USFWS, 2024)

Number of Populations:

15 springs and 2 caves (USFWS, 2024)

Adaptability:

Low (inferred from USFWS, 2014)

Additional Population-level Information:

Since these species were described, they have been documented at multiple new localities. This increase in known populations is likely due to an increase in surveyed locations over time that resulted in the discovery of previously unknown populations and is unlikely to represent newly established populations of these species. According to the USFWS database of known locations, the Jollyville Plateau salamander occurs in approximately 130 springs and caves in Travis and

Williamson counties. The Salado salamander is currently known from 15 springs/spring complexes and two caves in Williamson and Bell Counties, and the Georgetown salamander is known from 14 springs and one cave in Williamson County (USFWS, 2024)

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

Reclassification Criteria:
Recovery Priority Number: 2C

Recovery Actions:

- No Recovery Plan
- None specified

References

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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. 2024. Recovery Outline for the Georgetown Salamander, Jollyville Plateau Salamander, and Salado Salamander. Austin Ecological Services Field Office, Austin, Texas. 15 pp.

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

Final Rule. 79 Federal Register 36, February 24, 2014. Pages 10236-10293.

SPECIES ACCOUNT: *Eurycea nana* (San Marcos salamander)

Species Taxonomic and Listing Information

Listing Status: Threatened; Southwest Region (R2) (USFWS, 2016)

Physical Description

This dark, reddish-brown, slender salamander has moderately large eyes with a dark ring around the lens. The species has well developed and highly pigmented gills and relatively short, slender limbs with four toes on the fore feet and five toes on the hind feet. San Marcos salamanders have a slender tail with a welldeveloped dorsal fin. Males and females are not sexually dimorphic (USFWS, 2024).

Taxonomy

The San Marcos salamander (Eurycea nana) is a member of the family Plethodontidae (lungless salamanders). It is most closely related to E. latitans, E. sosorum, E. neotenes, E. pterophila, and an undescribed species from the Pedernales subbasin (Devitt et al. 2019, pp. 2627-2628). Eurycea nana is neotenic; they retain external gills and remain aquatic throughout their life cycle. The species was described by Bishop (1941, pp. 6-9) from specimens collected in 1938. (USFWS, 2024a)

Current Range

This species is found only in Spring Lake and downstream in the San Marcos River to approximately 152 m (500 ft) below the Spring Lake Dam (Tupa and Davis 1976, p. 191; Nelson 1993, pp. 19-20), and mainly occurs in the remnant river channel (Diaz et al. 2015, p. 317). A population genetic study did not find evidence of genetic differences among three different sampling sites in the San Marcos River and Spring Lake (Lucas et al. 2009, p. 223). While salamanders at some springs north of San Marcos have mitochondrial haplotypes similar to San Marcos salamanders (Bendik et al. 2013, p. 14), further analyses determined that those salamanders were Barton Springs salamanders, E. sosorum (Chippindale 2012, entire; Devitt et al. 2019, p. 2,627-2,628). The San Marcos salamander was also collected in 2015 and 2022 at the Texas State University Artesian well (Longley et al. 2015, Attachment 1; Castillo 2023, pers. comm.), indicating some subsurface habitat. (USFWS, 2024a)

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: Oviparity (USFWS, 2024)

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: Males are sexually mature at a snout-vent length of 1.9 centimeters (cm) (0.7 inches (in)) (Tupa and Davis 1976, p. 186), but both sexes continue to grow after sexual maturity. Courtship and eggs have not been observed in the wild. Because gravid females and juveniles are found throughout the year, reproduction likely occurs throughout the year (Tupa and Davis 1976, p. 190). In captivity, eggs were found on aquatic moss and on marbles (Najvar et al. 2007, p. 146).

Clutch size ranged from 2-73 eggs, with a mean of 34.7 eggs (Najvar et al. 2007, p. 146). Eggs hatched 16-24 days after oviposition (Najvar et al. 2007, p. 146). It is possible that the conditions in captivity, such as abundant food resources and lack of potential predation, allow captive salamanders to allocate more resources to egg production than is possible in the wild (Najvar et al. 2007, p. 146). San Marcos salamanders are generalist predators and prey on a variety of macroinvertebrates (Diaz 2010, p. 18). In a study of gut contents, they consumed the most common available taxa, including amphipods, ostracods, chironomids, caddisflies, and snails (USFWS, 2024).

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (Natureserve, 2015)

Habitat Narrative

Adult: San Marcos salamanders only live near springs in the San Marcos River, which has stable habitat conditions consistent with the San Marcos Springs in the City of San Marcos, Hays County, Texas. San Marcos salamanders are found in mesohabitats that contain cobble, gravel, and boulder substrates, and may use or benefit from cover provided by Amblystegium moss or filamentous algae (Diaz et al. 2015, pp. 307, 316).. Salamanders use interstitial spaces on or within the substrate and are less likely to be found in areas that have mud or silt substrates and rooted macrophytes, which embed the substrate that they use as cover features (Diaz et al. 2015, p. 316). The species displays a slight preference for water velocities of approximately 1 cubic centimeter per second (cm/s) (Fries 2002, pp. 113, 115). Higher velocities can wash away potential habitat while lower velocities allow sediment to settle into the interstitial spaces that they use as habitat. It seems likely that the species reproduces underground based on the lack of eggs found at the surface and documentation of other closely related Eurycea salamanders that use surface and subterranean habitat during their lifetime (USFWS, 2024).

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 (USFWS, 2024)

Population Size:

17,000-22,000; as many as 53,000 (USFWS, 2024)

Population Narrative:

San Marcos salamander density estimates are based on spring and fall sampling events since 2000 for specific areas that have active habitat management. The long-term average number of salamanders per square meter (m2) varies somewhat seasonally, particularly for Hotel Spring. In the Spring, the average number of individuals is approximately 15 individuals for Hotel Spring, 15 individuals for Riverbed and 5 individuals for Spring Lake Dam; in the Fall, the average is 26 individuals for Hotel Spring, 13 individuals for Riverbed, and 6 individuals for Spring Lake Dam (BIO-WEST, Inc., 2023, p. 46). Salamander densities are typically higher during low-flow years than during high-flow years (BIO-WEST, Inc., 2023, p. 46). In 2023, the density of salamanders was lower in in the fall than in the spring (BIO-WEST, Inc. 2023, p. 46). Salamander density was consistently lower at Spring Lake Dam and Hotel Spring in 2023 than the low-flow average, but higher at Riverbed (BIO-WEST, Inc. 2023, p. 46). Efforts to estimate San Marcos salamander populations is intensive and somewhat limited because juveniles are small, and salamanders can move undetected into interstitial spaces in the substrate.. Mark-recapture methods would most likely focus on salamanders at the surface. Population genetics could provide a total population estimate but would likely not distinguish between the surface and subsurface individuals. Previous population estimates for the San Marcos salamander have ranged from 17,000 to 21,000 individuals in the floating algal mats at the uppermost portion of Spring Lake (Tupa and Davis 1976, pp. 92-93), to as many as 53,200 salamanders from Spring Lake and the rocky substrates within about 46 meters (m) (150 feet (ft)) downstream of the Spring Lake Dam (USFWS, 2024). The San Marcos salamander is only found in Spring Lake and downstream in the San Marcos River to approximately 152 m (500 ft) below Spring Lake Dam (Tupa and Davis 1976, p. 191; Nelson 1993, pp. 19-20). The species was also collected in 2015 at the Texas State University Artesian well (Longley et al. 2015, Attachment 1) indicating the species may utilize subsurface habitats (USFWS, 2024)

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

Reclassification Criteria:

Recovery Priority Number: 2C

Delisting Criteria:

1. All species: All populations maintain resiliency for 45 consecutive years and are expected to maintain resiliency in the future. Populations will be considered resilient when they meet the definition described in downlisting criterion 1 above. For the San Marcos salamander, the criterion for surface species should be followed. (USFWS, 2025)

2. All species: Habitat can sustain resilient populations and is protected/restored/maintained as described above in downlisting criterion 2, maintained for at least 45 years, and anticipated to remain protected/restored/maintained due to the actions of the habitat management plan described in downlisting criterion 3. Habitat for the San Marcos salamander is not included in downlisting criterion 2 and should meet the criteria provided for all species, as well the following for the San Marcos ecosystem: Approximately 6000 m2 (0.6 ha [1.5 ac]) of unembedded cobble and gravel substrate with low macrophyte cover is maintained through Spring Lake and the upper 50 m (164 ft) of the river when flows are above 2.3 m3 /s (80 cfs) and maintain at least 3000 m2 (0.3 ha [0.7 ac]) of unembedded substrate when flows are below 2.3 m3 /s (80 cfs). Surface habitat should connect to a groundwater source, such as a spring. (USFWS, 2025)

3. All species: Future habitat degradation is prevented through a habitat management plan as described above in downlisting criterion 3. The habitat management plan will be fully implemented for at least 45 years and anticipated to continue for at least 75 years into the future. (USFWS, 2025)

4. All species: The flows in downlisting criterion 4 are achieved for 45 years. Flows are expected to continue for at least 75 years into the future through actions of a fully implemented water management plan. (USFWS, 2025)

5. All species: Groundwater quality in downlisting criterion 5 is achieved for 45 years and there is no indication that water quality is degrading over time, as determined by increasing trends in nutrients, conductivity, or contaminants. (USFWS, 2025)

6. All species: Captive populations continue to be maintained as described in downlisting criterion 6. This will continue until the five years of post-delisting monitoring is completed. (USFWS, 2025)

7. Fountain darter, San Marcos salamander, Texas blind salamander: Disease and parasites do not affect the resiliency of any wild population for 45 years as defined in downlisting criterion 7 and are not anticipated to affect the resiliency for at least 75 years into the future. (USFWS, 2025)

Recovery Actions:

- Recovery Action 1. Ensure Adequate Water Quantity and Quality within the Southern Edwards Aquifer and Management Units. Priority 1. (USFWS, 2025)
- Recovery Action 2. Protect and Restore Habitat in Waters and on Lands Within and Adjacent to the Management Units. Priority 1. (USFWS, 2025)
- Recovery Action 3: Establish and Implement Captive Refugia Populations with a Captive Population Management Plan and Reintroduction Plan. Priority 1 for San Marcos salamander, Texas blind salamander, Texas wild-rice; Priority 2 for Comal Springs riffle beetle, Comal Springs dryopid beetle, Peck's cave amphipod, fountain darter. (USFWS, 2025)

- Recovery Action 4: Promote Edwards Aquifer Species Conservation and Recovery through Outreach, Education, and Cooperation. Priority 3. (USFWS, 2025)
- Recovery Action 5: Establish and Implement Effective Disease and Parasite Protocols. Priority 2. (USFWS, 2025)
- Recovery Action 6. Monitor Progress Toward Criteria within the Management Units: Priority 3. (USFWS, 2025)

References

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USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/ecp0/. Accessed July 2016. USFWS. 2024. San Marcos Salamander (Eurycea nana) 5-Year Review: Summary and Evaluation. Austin Ecological Services Field Office, Austin, Texas. 36 pp. USFWS. 2024a. Species Biological Report for Southern Edwards Aquifer Springs and Associated Aquatic Ecosystems. Southwest Region, Albuquerque, New Mexico. 117 pp.

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. USFWS. 2024. San Marcos Salamander (Eurycea nana) 5-Year Review: Summary and Evaluation. Austin Ecological Services Field Office, Austin, Texas. 36 pp.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.” USFWS. 2024. San Marcos Salamander (Eurycea nana) 5-Year Review: Summary and Evaluation. Austin Ecological Services Field Office, Austin, Texas. 36 pp.

USFWS. 2025. Final Recovery Plan for the Southern Edwards Aquifer Springs and Associated Aquatic Ecosystems, Second Revision. U.S. Fish and Wildlife Service, Southwest Region, Albuquerque, New Mexico, USA. 40 pp.

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). The Georgetown, Salado, and Jollyville Plateau salamanders are endemic to the northern segment of the Edwards Aquifer in Bell, Travis, and Williamson counties, Texas (Figures 1 and 2 below; Devitt et al. 2019, p. 2629). Genetic research conducted since the species listing assessed population structure, phylogeny, and distribution of multiple Eurycea species across central to west-central Texas (Devitt et al. 2019, entire). The results of that work had substantial taxonomic and distributional implications for several of the region's Eurycea species, including the Georgetown and Salado salamanders. Salamanders from the Berry Creek watershed, formerly assigned to the Georgetown salamander, were noted to be genetically similar to the Salado salamander and assigned to the latter species (Devitt et al. 2019, p. 2629). This reassignment of populations expanded the range of the Salado salamander to the south into Williamson County and reduced the range of the Georgetown salamander to sites south and east of Lake Georgetown in the watersheds of the North and Middle Forks of the San Gabriel River (Devitt et al. 2019, p. 2629). A single salamander collected from San Gabriel Springs, long considered the Georgetown salamander, was found to be more genetically similar to the Jollyville Plateau salamander and assigned to that Eurycea species (USFWS, 2024).

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:
Increasing (USFWS, 2024)

Number of Populations:
14 springs and 1 cave (USFWS, 2024)

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). Since these species were described, they have been documented at multiple new localities. This increase in known populations is likely due to an increase in surveyed locations over time that resulted in the discovery of previously unknown populations and is unlikely to represent newly established populations of these species. According to the USFWS database of known locations, the Jollyville Plateau salamander occurs in approximately 130 springs and caves in Travis and Williamson counties. The Salado salamander is currently known from 15 springs/spring complexes and two caves in Williamson and Bell Counties, and the Georgetown salamander is known from 14 springs and one cave in Williamson County (USFWS, 2024)

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

Reclassification Criteria:
Recovery Priority Number: 2C

Recovery Actions:
- No Recovery Plan
- None specified

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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

Final Rule. 79 Federal Register 36, February 24, 2014. Pages 10236-10293.

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)

Recovery Priority Number: 2

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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USFWS. 2019. Barton Springs Salamander (Eurycea sosorum) 5-Year Review: Summary and Evaluation U.S. Fish and Wildlife Service Austin Ecological Services Field Office Austin, Texas. 52 pp.

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). The Georgetown, Salado, and Jollyville Plateau salamanders are endemic to the northern segment of the Edwards Aquifer in Bell, Travis, and Williamson counties, Texas (Figures 1 and 2 below; Devitt et al. 2019, p. 2629). Genetic research conducted since the species listing assessed population structure, phylogeny, and distribution of multiple Eurycea species across central to west-central Texas (Devitt et al. 2019, entire). The results of that work had substantial taxonomic and distributional implications for several of the region’s Eurycea species, including the Georgetown and Salado salamanders. Salamanders from the Berry Creek watershed, formerly assigned to the Georgetown salamander, were noted to be genetically similar to the Salado salamander and assigned to the latter species (Devitt et al. 2019, p. 2629). This reassignment of populations expanded the range of the Salado salamander to the south into Williamson County and reduced the range of the Georgetown salamander to sites south and east of Lake Georgetown in the watersheds of the North and Middle Forks of the San Gabriel River (Devitt et al. 2019, p. 2629). A single salamander collected from San Gabriel Springs, long considered the Georgetown salamander, was found to be more genetically similar to the Jollyville Plateau salamander and assigned to that Eurycea species (USFWS, 2024).

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:
Increasing (USFWS, 2024)

Number of Populations:
130 springs and caves (USFWS, 2024)

Population Size:
Unknown (NatureServe, 2015)

Additional Population-level Information:
Since these species were described, they have been documented at multiple new localities. This increase in known populations is likely due to an increase in surveyed locations over time that resulted in the discovery of previously unknown populations and is unlikely to represent newly established populations of these species. According to the USFWS database of known locations, the Jollyville Plateau salamander occurs in approximately 130 springs and caves in Travis and Williamson counties. The Salado salamander is currently known from 15 springs/spring complexes and two caves in Williamson and Bell Counties, and the Georgetown salamander is known from 14 springs and one cave in Williamson County (USFWS, 2024)

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.

Recovery Priority Number: 2C

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: *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

Reclassification Criteria:
Recovery Priority Number: 2C

(1) the Barton Springs watershed is sufficiently protected to maintain adequate water quality (including sediment quality) and ensure the long-term survival of the Barton Springs salamander in its natural environment (USFWS, 2005)

2) a plan is implemented to avoid, respond to, and remediate hazardous material spills within the Barton Springs watershed such that the risk of harm to the Barton Springs salamander is insignificant (USFWS, 2005)

(3) an Aquifer Management Plan is implemented to ensure adequate water quantity in the Barton Springs watershed and natural springflow at the four spring outlets that comprise Barton Springs (USFWS, 2005)

(4) healthy, self-sustaining natural populations of Barton Springs salamanders are maintained at the four spring sites (USFWS, 2005)

(5) surface management measures to remove local threats to the Barton Springs ecosystem have been implemented (USFWS, 2005)

captive breeding populations have been established and a contingency plan is in place to ensure the survival of the species should a catastrophic event destroy the wild population. (USFWS, 2005)

Delisting Criteria:
(1) the measures listed above have been implemented and shown to be effective (USFWS, 2005)

(2) the Barton Springs salamander populations continue to be self-sustaining and stable (USFWS, 2005)

commitments are in place to maintain conservation measures and recovered status. (USFWS, 2005)

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.
- (1) Protect and, as necessary, improve water quality (including the quality of sediment) within the Barton Springs watershed. (2) Minimize catastrophic water quality threats. (3) Sustain adequate water quantity at Barton Springs. (4) Manage surface habitat at Barton Springs. (5) Maintain captive populations of Barton Spring salamanders for research and restoration purposes. (6) Develop and implement an outreach plan. (7) Monitor the current salamander populations and the results of recovery efforts. (USFWS, 2005)

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

Recovery Priority Number: 2

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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U.S. Fish and Wildlife Service. 2018. Recovery Outline for Black Warrior Waterdog (Necturus alabamensis.

SPECIES ACCOUNT: *Plethodon nettingi* (Cheat Mountain salamander)

Species Taxonomic and Listing Information

Commonly-used Acronym: CMS

Listing Status: Threatened; 08/18/1989; Northeast Region (Region 5) (USFWS, 2015)

Physical Description

Plethodon nettingi reaches a maximum length of 4.0 inches (Conant 1975) and has 17-19 costal grooves (Highton 1971). The dorsal color is blackish, usually with brassy or white flecks. The ventral region is dark gray to black. (USFWS, 1991)

Taxonomy

Three salamander species found within its range bear some morphological resemblance to the Cheat Mountain salamander: the redback salamander (P. cinereus), Wehrle's salamander (P. wehrlei), and the mountain dusky salamander (Desmognathus ochrophaeus). All of these species have been found to be associated with the Cheat Mountain salamander in all known populations (Pauley 1980; Kroschel et al. 2014; Rucker et al. 2021, in review). While typical specimens of each species are fairly easy to distinguish, there are phase and size variations that can be confusing, including the leadback phase of the redback salamander, and dark phases of the mountain dusky salamander and small Wehrle's salamanders. The leadback phase of the redback salamander can be distinguished from the Cheat Mountain salamander by a mottled (salt and pepper) venter as opposed to the dark gray venter of the latter species. The mountain dusky salamander has a chunkier body, larger hind legs relative to the front, a white line or spot between the eyes and angle of the jaws, and 14 costal grooves. Juvenile Wehrle's salamanders differ from the Cheat Mountain salamander by the presence of small orange spots on the dorsum, white spots along their sides, and a whitish chin and throat. (USFWS, 1991) Identification of CMS should only be undertaken by those trained in identification of all three species, as there are variations in body base color and flecking pattern and colors of the CMS across its range. Additionally, adult CMS may exhibit confusing speckling patterns in their breeding season.

Historical Range

Known in the Allegheny Mountains from Cheat Mountain north to Back Allegheny and Cabin mountains, in Grant, Tucker, Randolph, Pocahontas, and Pendleton counties, West Virginia, at elevations of 908-1463 m (Pauley 1993); much of remaining habitat is within Monongahela National Forest (see Green and Pauley [1987] for more specific information). One population extends to below 730 meters (1992 End. Sp. Tech Bull. 17(12):18). High mountains of east-central West Virginia from Backbone Mountain, Tucker County, in the north to Thorny Flat, Pocahontas County, in the south; generally found above 1,130 meters (3,500 feet) but extends down to 852 meters (2,640 ft) in the northern part of the range (West Virginia Division of Natural Resources web site, 1998).The entire range encompasses 2,400 square kilometers (935 square miles), within which the species occurs in many disjunct populations (West Virginia Division of Natural Resources web site, 1998). (NatureServe, 2015)

Current Range

Allegheny Mountains from Cheat Mountain north to Back Allegheny and Cabin mountains, in Grant, Tucker, Randolph, Pocahontas, and Pendleton counties, West Virginia. The current range of the species is described as extending over approximately 695 square miles from Blackwater River Canyon (Tucker County) in the north, south to Thorny Flat (Pocahontas County) (~57 miles) and from Cheat Mountain in the west, and to Allegheny Front in the east (~19 mi). (USFWS, 2009) As described in Pauley (2007), the Cheat Mountain salamander is "presently known to occur in five counties in the Allegheny Mountains of eastern West Virginia: Randolph, Pendleton, Pocahontas, Tucker, and the most western edge of Grant County along the Allegheny Front. The total range extends from Blackwater River Canyon (Tucker County) in the north, south to Thorny Flat (Pocahontas County) (approximately 58 miles) and from Cheat Mountain in the west, east to the Allegheny Front (approximately 19 miles)." Within this overall range, the Cheat Mountain salamander is restricted to a number of disjunct high elevation ridges and is only known to occur above elevations of 2000 feet in the northern part of the potential range and above 3500 feet in the southern part of the potential range (Pauley 2007). Distribution of the salamander is discontinuous and is restricted to the higher elevations of 12 mountains: Allegheny Front, Back Allegheny, Backbone, Cabin, Canaan, Cheat, Little Middle, McGowan, Rich (east), Mozark, Shavers, and Spruce (Service 1991). Throughout the species range, approximately 81 discrete populations of the Cheat Mountain salamander have been documented since 1976 (Pauley 2008; Pauley 2021, in review). Since that time, one of these populations and possibly two others have been extirpated, and two have been reduced in size (Pauley 2007). It is difficult to determine Cheat Mountain salamander abundances within each of the remaining populations because standard search times were not used during searches and more than one search has been conducted at some populations (Pauley 2008). Therefore, determination of population size is tentatively based on area, and Pauley (2008) defined those populations that cover greater than one acre as "large ." Sixty-six of the known populations fall into the large population category (Pauley 2008). Most known populations of CMS are within the boundaries of the MNF which provides them protection from some habitat disturbances (Pauley, et al. 2005).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food Source

<u>Juvenile:</u> Eats various small terrestrial invertebrates (e.g., mites, springtails, beetles, flies, ants) (Green and Pauley 1987). (NatureServe, 2015)

<u>Adult:</u> Eats various small terrestrial invertebrates (e.g., mites, springtails, beetles, flies, ants) (Green and Pauley 1987). (NatureServe, 2015)

Competition

<u>Adult:</u> Hairston (1980) found that narrow population overlaps (less than 400 feet) between Plethodon glutinosus and P. jordani resulted in keen interspecific competition whereas broad population overlaps (over 400 feet) resulted in reduced competition. In populations studied for vertical distribution, populations overlaps between P. nettingi and P. cinereus were 300 feet or

less and overlaps between P. nettingi and D. ochrophaeus were 320 feet. Considering Hairston's results and the narrow vertical overlap between the Cheat Mountain salamander and the redback and mountain dusky salamanders, competition among these three species is probably very keen. In addition, laboratory studies by Pauley (1980) and Pauley and Pauley (1990) demonstrated that P. netting] is not as keen a competitor for limited resources as P. cinereus and D. ochrophaeus. (USFWS, 1991) Fragmentation of forests and removal of the forest canopy creates gradients of environmental factors from the edge into the forest that may increase the natural level of interspecific competition (Pauley and Watson 2003). Rucker et al. (2021, in review) recently found that over the 28 year study monitoring window at a disturbed site, while Cheat Mountain salamanders were disappearing from survey sites closer to the disturbed area, the colonization rates of two competitors, Eastern red-backed and Wehrle's salamanders (Plethodon wehrlei), were increasing. It is unknown if the two competitor species were benefitting from the creation of more favorable conditions due to increased solar radiation closer to the disturbance edge or from reduced competition with Cheat Mountain salamanders, or a combination of the two factors. Similarly, Kroschel et al. (2014) found that at other mid- to high-elevation Cheat Mountain salamander study sites in West Virginia, Cheat Mountain salamander populations declined over a 32-year period, while red-backed salamander populations apparently expanded their vertical distribution. The researchers were unable to determine the extent of influence that inter-specific competition between the two species had on this trend, as there were concurrent environmental changes (i.e. altered weather patterns and habitat disturbance) across the study areas. Finally, it is likely that smaller populations of Cheat Mountain salamanders and populations that are already fragmented, could be more susceptible to interspecific competition and competitive stress, which may place these populations at further risk (Pauley 2008).

Food/Nutrient Narrative

Adult: The Cheat Mountain salamander is an invertivore that eats various small terrestrial invertebrates (e.g., mites, springtails, beetles, flies, ants) (Green and Pauley 1987). Active primarily from April through October (Pauley, pers. comm. to Petranka 1998). Activity may occur during wet or dry weather, but this salamander is most active at night in humid weather (Green and Pauley 1987). Hairston (1980) found that narrow population overlaps (less than 400 feet) between Plethodon glutinosus and P. jordani resulted in keen interspecific competition whereas broad population overlaps (over 400 feet) resulted in reduced competition. In populations studied for vertical distribution, populations overlaps between P. netting and P. cinereus were 300 feet or less and overlaps between P. netting and D. ochrophaeus were 320 feet. Considering Hairston's results and the narrow vertical overlap between the Cheat Mountain salamander and the redback and mountain dusky salamanders, competition among these three species is probably very keen. In addition, laboratory studies by Pauley (1980) and Pauley and Pauley (1990) demonstrated that P. netting] is not as keen a competitor for limited resources as P. cinereus and D. ochrophaeus. (NatureServe, 2015; USFWS, 1991)

Reproductive Strategy

Adult: Oviparity (USFWS, 1991)

Lifespan

Adult: ~20 years (USFWS, 1991)

Breeding Season

Adult: March to April (USFWS, 2010)

Key Resources Needed for Breeding

Adult: Temperature and moisture dependent (USFWS, 2010)

Other Reproductive Information

Adult: Females attending small clusters of eggs have been found from late April through early September (Bishop 1943, Brooks 1948, Green and Pauley 1987). Larval stage is passed in egg. Hatching occurs in August-September. (NatureServe, 2015)

Reproduction Narrative

Egg: Hatching occurs in August-September. (NatureServe, 2015)

Larvae: Larval stage is passed in egg. (NatureServe, 2015)

Adult: Little is known about the reproductive biology of the Cheat Mountain salamander. The presence of salamanders on the surface is dependent on ambient temperature and moisture. Brooks (1948) observed nests from May 28 to August 25 with four to 17 eggs. All nests Brooks found were in well-decayed spruce logs. Females attending small clusters of eggs have been found from late April through early September (Bishop 1943, Brooks 1948, Green and Pauley 1987). Hatching occurs in August-September. Larval stage is passed in egg. The age at which P. nettingi becomes sexually mature has not been determined. Its growth patterns are probably similar to its sympatric congener P. cinereus. Sayler (1966), in a study in Maryland, found that P. cinereus males become sexually mature at age three and females at age four. While the life span of P. nettingi has not been studied, most small Plethodon live approximately 20 years. Since eggs are probably laid in alternate years, females can potentially rear eight broods. (NatureServe, 2015; USFWS, 2010; USFWS, 1991) Deposited CMS eggs are in small grape-like clusters suspended from the underside of a rock or log or in log cavities or subterranean cavities. Pauley observed 25 CMS nests, 23 with eggs between May 15 and July 26, and two with neonates on September 4th and 12th. Egg clutch sizes varied from 5 to 11 (Pauley 2008). In all nests observed by Pauley, females were in attendance. As with CMS, female eastern red-backed salamanders guard the eggs during development (Bishop 1941; Highton and Savage 1961). Sayler (1966) concluded that spent eastern red-backed females, i.e., those that have deposited their eggs and have guarded their nest during embryo development, leave the nest approximately 6 to 8 weeks (August) after egg deposition. Pauley's nesting data suggest CMS deposit eggs about June 1 and the eggs hatch around September 1, in approximately 90 days, rather than the 40 to 60 days Sayler (1966) predicted for eastern red-backed salamanders. (all from Pauley 2021, in review)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest - Conifer, Forest - Hardwood, Forest - Mixed (NatureServe, 2015) Of Pauley's 195 collection sites, 108 (55.4%) were in red spruce stands, 27 (13.8%) in mixed deciduous tree species stands, 19 (9.7%) in mixed red spruce and deciduous tree stands, 19 (9.7%) in eastern hemlock stands, 10 (5.1%) in mixed red spruce and eastern hemlock stands, eight (4.1%) in a mixed red spruce, eastern hemlock, and deciduous stands, and four (2.1%) in mixed eastern hemlock and deciduous stands. While these data indicate the original and probably the optimal habitat of CMS is a red spruce forest, CMS can survive in eastern hemlock and deciduous tree stands. Pauley 2021, in review.

Dependencies on Specific Environmental Elements

Adult: Cooler tempratures, high relative humidity (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 908 and 1463 m (NatureServe, 2015). Elevational range of known CMS populations is approximately 731 m in Blackwater Canyon to 1482 m at Spruce Knob, the highest elevation in West Virginia. Based on personal observations of potential habitat occurrences throughout the known range of CMS, Pauley believes they could occur in appropriate habitat at elevations above 610 m in the extreme northern limit of the range and above 914 m in the remainder of the range. (Pauley 2021, in review).

Spatial Arrangements of the Population

Adult: 81 disjunct populations throughout the range.

Environmental Specificity

Adult: Moderate. Generalist or community with some key requirements scarce (NatureServe, 2015)

Site Fidelity

Adult: High (USFWS, 1991)

Habitat Narrative

Egg: Eggs have been found in and under rotting logs, and under rocks (Brooks 1948, Green and Pauley 1987). (NatureServe, 2015)

Adult: The Cheat Mountain salamander (CMS) is found primarily in red spruce-yellow birch or spruce-dominated forests and occasionally collected in mixed deciduous hardwoods (Brooks 1945, 1948; Clovis 1979; Green and Pauley 1987). They typically occur in bryophytes and downed logs are usually common. Occurs under rocks and in or under logs during day; sometimes among wet leaves. Active on forest floor at night; may climb lower portions of tree trunks (Brooks 1945, 1948; Green and Pauley 1987). Eggs have been found in and under rotting logs, and under rocks (Brooks 1948, Green and Pauley 1987). (NatureServe, 2015). Cheat Mountain salamanders use underground refugia to avoid dry, hot weather during summer and to overwinter (Pauley 2008b, Petranka 1998 in Dillard et al. 2008b). CMS exit these covered habitats to forage on the surface when moist, cool microclimatic conditions allow for cutaneous respiration (Feder 1983, Owen 1989, Grover 1998, Petranka 1998, Welsh et al. 2006; all in Dillard et al. 2008). Because CMS are lungless, sufficient moisture must be present for respiratory exchange to occur directly through the skin (USFWS 1991). As a result, CMS require microhabitats with high relative humidity or moisture and acceptable temperatures (Feder and Pough 1975, Feder 1983; in USDA Forest Service 2008a). (USFWS, 2009; NatureServe, 2015)

Dispersal/Migration

Motility/Mobility

Adult: Low (USFWS, 1991)

Dispersal

Adult: Low (USFWS, 1991)

Dispersal/Migration Narrative

Adult: In a preliminary study, Pauley (unpubl. data) found that P. nettingi probably did not move more than one linear meter. This is well within the home ranges found in studies of otherPlethodon species; for example, Kleeberger and Werner (1982) found the home range of P. cinereus to be from 12.97 to 24.34 square meters. (USFWS, 1991) One juvenile male CMS was found dispersing approximately 50 feet from occupied CMS habitat (Service 2018).

Population Information and Trends

Population Trends:

Long-term trends suggest declines of <50% to relatively stable, whereas short-term trends indicate a relatively stable population (NatureServe, 2015) Ten populations were selected recently for monitoring by the WV Division of Natural Resources. Of these 10, 5 are thought to be stable, 1 is stable to declining, 1 is declining, and 3 are unknown trends (WVDNR 2021).

Resiliency:

No SSA has been completed for this species.

Representation:

No SSA has been completed for this species. Genetic analyses have identified differing genetic structuring across the species range and indicate limited to no connectivity between populations sampled (Hammer and Arbogast 2016). Genetic data indicate that approximately 20% of the population size of has been lost over the last 1,000 years (Hammer and Arbogast 2016). The extent and connectivity of populations is presumed to be limited as result of historical anthropogenic impacts, including extensive clearcutting and wildfires (Pauley 2008).

Redundancy:

No SSA has been completed for this species.

Population Growth Rate:

Unknown

Number of Populations:

66 large (>1 acre) populations (USFWS, 2009); 81 disjunct populations (Pauley 2021, in review).

Population Size:

Unknown

Minimum Viable Population Size:

Unknown

Resistance to Disease:

Unknown

Adaptability:

Unknown

Population Narrative:

Total adult population size is unknown but probably is at least several thousand. Populations generally are small (a few may include over a thousand individuals). Long-term trends suggest declines of <50% to relatively stable, whereas short-term trends indicate a relatively stable population. (USFWS, 2009; NatureServe, 2015)

Threats and Stressors

Stressor: Habitat loss (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Cheat Mountain salamander (CMS) populations on private land are subject to direct habitat loss and alteration due to logging and development. CMS are known to occur throughout the West Ridge subdivision in Pocahontas County and houses have been built on 46% of the lots, fragmenting much of the CMS habitat present in the area, and development continues on the remaining lots. CMS are also known to occur within 2,700 acres of privately-owned lands in Blackwater Canyon in Tucker County. Approximately 1,600 acres are potentially slated for logging, and an additional unquantified but smaller acreage is proposed for development. In some instances, private entities may own mineral rights beneath both private and federally owned lands. Private entities may seek to develop their mineral rights within CMS habitats. The threat of habitat loss and alterations from these activities is ongoing. (USFWS, 2009)

Stressor: Habitat fragmentation (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Anthropogenic habitat fragmentation and alteration continue to affect almost all of the known CMS populations, including those that are on public lands and protected (Pauley 2008a). Threats such as roads, ski trails, powerline rights-of-way, and adjacent logging or development were noted for 86% of the CMS areas that have been surveyed since the species was listed (WVDNR 2009). Habitat fragmentation and tree removal open the interior of the forest floor to increased amounts of sunlight and wind, resulting in an increase in soil temperature and a decrease in soil moisture and changing the microclimatic conditions on the forest floor from mesic to xeric (USFWS, 1991, Pauley 2008a). Since the CMS requires moist, cool habitats, any alteration of the habitat that reduces soil moisture and/or relative humidity can lead to adverse effects such as reduced reproductive success through nest desiccation (USFWS 1991; Pauley 2008a). Loss of soil and litter moisture and increased soil temperature observed at the edges of disturbances may contribute to the loss of salamanders (Pauley and Watson 2003). Disruptions of habitat may also lead to fragmentation or dissection of single, large populations into smaller subunits and create barriers to dispersal and gene flow (Pauley and Watson 2003, Pauley 2008a). The loss of genetic material in a population can reduce genetic variability and could be costly to populations if diseases are introduced or other ecosystem changes should occur (Pauley 2008a). Fragmented, smaller populations may also be more susceptible to extirpation due to nature

pressures such as periods of drought and interspecific competition (USFWS, 1991, Vos and Chardon 1998 in Pauley and Watson 2003). Pauley (unpubl. data) found that roads, and potentially some trails, serve as barriers that prevent territories of different individuals from overlapping, thus fragmenting populations and gene pools. Heavily traveled trails can result in removal of leaves and other forest litter, leaving bare trail treads (USFWS, 1991; WVDNR 1999, 2000). Preliminary data suggest that CMS rarely cross trails and other openings that lack sufficient leaf litter cover (Pauley 2005 in Pauley and Waldron 2008). CMS use forest floor litter as foraging cover and refugia, especially during the day. Removal of this litter can create a barrier to these activities and render them unsuitable for territories (USFWS 1991; WVDNR 1998, 2000; Pauley and Waldron 2008). Such barriers could also interfere with reproduction, since mating apparently occurs where territories overlap (Horne 1988 in USFWS 1991). (USFWS, 2009)

Stressor: Interspecific competition (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Habitat alterations and fragmentation may also increase the threat of inter-specific competition. The recovery plan noted that inter-specific competition with species such as the redback salamander and the mountain dusky salamander may limit the ability of the CMS to retain populations within its range or re-populate previously occupied areas (54 FR 34464-34468). CMS and the mountain dusky salamander require moister soils than the redback salamander and therefore, compete for moist spots. CMS and the redback salamander have the same body size, consume the same primary and secondary prey items, and deposit eggs at the same time of the year and in the same nesting sites, and they thus compete for food and nesting sites. Dehydration rate studies have demonstrated that CMS loses body moisture faster than the redback salamander (Pauley 2005, Pauley 2008a). CMS is not as keen a competitor for limited resources as the other two species and that competition among these three species is probably very keen (USFWS 1991, Pauley 2005). (USFWS, 2009) A recent study found a concurrent rise in occupation of areas nearer disturbance by competitor species (red-backed and Wherli's salamanders), which indicates that the potential for interactions with these competitors is increasing, and that these competitors may be benefitting from the increased solar radiation or reduced competiton with CMS (Rucker et al. 2021)

Stressor: Predation (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The CMS is susceptible to increased predation from snakes and other predators that access CMS habitat through forest openings created by roads, ski slopes, and utility rights-of-way. Typically, snake species such as gartersnakes (Thamnophis sirtalis), ring-necked snakes (Diadophis punctatus edwardsii), and red-bellied snakes (Storeria occipitomaculata) that prey on salamanders are less common in cool, moist forests where CMS are commonly found (Pauley 2008a). Features that fragment CMS habitat and create forest openings can create habitat conditions that are more conducive for predators. (USFWS, 2009)

Stressor: Chytridiomycosis (USFWS, 2009)
Exposure:
Response:

Consequence:
Narrative: Chytridiomycosis has recently been lined to multiple amphibian mass mortality and extinction events (Cummer et al. 2005, Greathouse and Pauley 2008). The disease is a result of infection from the chytrid fungus (Batrachochytrium dendrobatidis); it causes mortality by disturbing cutaneous respiration and the balance of oxygen, water, and electrolytes across the amphibian's skin (Cummer et al. 2005; Bakal et al. 2007 in Greathouse and Pauley 2008). Bd has been detected in some salamander species in West Virginia, but was not detected in CMS (Seeley et al. 2016; Bartkus 2009). Although the fungus has currently not been documented within the range of CMS, it is spreading rapidly across regions and through amphibian populations (Vredenburg et al. 2007, Greathouse and Pauley 2008). (USFWS, 2009)

Stressor: Drought (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Drought decreases soil moisture and thus has similar effects to those discussed under habitat modifications. Drought conditions in recent years may have had a severe and negative effect on the success of nests throughout the range of CMS (Pauley 2008a). Nests are characteristically found under rocks, logs, and bark on logs. These nesting sites are susceptible to desiccation during drought events (Pauley 2008a). (USFWS, 2009)

Stressor: Acid precipitation/deposition (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Pollution factors such as acid precipitation may also affect the survival of the CMS. The range of the CMS continues to be the recipient of some of the highest acid deposition in the nation, mainly due to its location downwind of many old coal-fired power plants that have minimal or no pollution controls. High sulfate deposition from sources in the Ohio River Valley has contributed to acidification of streams and may have affected soil quality and productivity on parts of the MNF and other high elevations of West Viriginia. Research scientists have found evidence of nutrient depletion in certain soils on the MNF (Jenkins 2002 and Sponaugle 2005 in USDA Forest Service 2008b; Adams et al. 2006). The combination of high emissions and limited buffering capacity of certain geology and soil types found on the MNF has led to increased acidity in stream water and possibly changes in soil chemistry. Since CMS directly inhabit the soil, they are likely to be susceptible to changes in soil chemistry due to acid deposition, and this could, therefore, ultimately affect the ability of habitats to support the CMS (USDA Forest Service 2008b). Acid deposition has been implicated in the build-up of heavy metals in the soil and the release of aluminum into soil solutions (Ulrich et al. 1980, Gibson and Linhurst 1982; in Wyman and Hawksley-Lescault 1987). These factors may result in the exclusion of young or adult Plethodons from affected soils (Wyman and Hawksley-Lescault 1987). (USFWS, 2009)

Stressor: Climate Change
Exposure:
Response:
Consequence:
Narrative: As the climate changes, competitor salamanders are becoming more prevalent in areas occupied by the Cheat Mountain Salamander (Kroschel et al. 2014, Rucker et al. in review),

and increased competition may threaten the long-term viability of Cheat Mountain Salamander populations (Pauley 1981). Climate change may also directly impact habitat quality for the Cheat Mountain Salamander; additional research is needed to quantify habitat quality thresholds to allow for tracking the impacts of climate change beyond general forest structure characteristics. Based on a pilot study (Brown et al. 2021 in review), soil moisture was a useful variable for separating occupied sites from seemingly high quality habitat non-detection sites. Thus, soil moisture could be an important factor influencing occupancy dynamics, and thus an important variable for

Stressor: Pesticide Use
Exposure:
Response:
Consequence:
Narrative: Stresses assoicated with pesticides, fertilizer, disease, and habitat loss and alteration have caused the greatest declines in amphibians (Wake and Vredenburg 2008, Hayes et al. 2010). Amphibians are thought to be particularly susceptible to the effects of chemicals in their environment, due to their thin, permeable skin, and effects can be lethal or sub-lethal. Crayton et al. (2020) found that the pesticide, imidacloprid, bioaccumulated in tissues of stream salamanders and their macroinvertebrate prey items in West Virginia. Similarly, evidence of disruption of the thyroid endocrine function in the larval stage of a salamander species in the northwest was recently documented (Danis and Marlatt 2021). However, much more research is needed in this area.

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Recovery Priority Number: 8C

Delisting Criteria:
1. Ten P. nettingi populations, representing both large and small populations and distributed range-wide, are shown to be stable or expanding over a period of ten years. (USFWS, 1991)

2. At least 100 extant populations throughout the range are permanently protected. Permanent protection will consist of public stewardship of Cheat Mountain salamander habitat by the U.S. Forest Service, U.S. Fish and Wildlife Service, State of West Virginia, The Nature Conservancy, etc. (USFWS, 1991)

3. Sufficient life history information exists to conduct appropriate management, as needed. (USFWS, 1991)

4. Regular monitoring and management programs are established and scheduled over a period that will extend at least five years beyond the time of delisting. (USFWS, 1991)

Recovery Actions:
- Define the total range of the species. (While the northern, eastern, and western limits of the range are generally known, there is still some question as to its southern extent.) (USFWS,

1991)
- Survey additional areas within the known range to gain additional information about the species’ distribution and abundance. (USFWS, 1991)
- Monitor known populations to determine their status, territoriality, home range, environmental changes, and competitive pressures. (USFWS, 1991)
- Assess population characteristics. (USFWS, 1991)
- Determine the effects of human-induced habitat alterations. (USFWS, 1991)
- Determine biological factors such as reproductive biology, growth rates, and genetic variability among populations. (USFWS, 1991)
- Additional work needs to be done to define what constitutes a Cheat Mountain salamander population and to evaluate existing data in relation to that definition (USFWS, 2009)
- A monitoring program should be developed using consistent methods. Monitoring protocols should be designed to evaluate long-term population trends and changes in density, abundance, and distribution. Existing survey data should be systematically reviewed and analyzed to help determine appropriate monitoring strategies and overall population viability. (USFWS, 2009)
- Benchmark population should be established and monitored using the developed protocol on a regular basis. (USFWS, 2009)
- Additional monitoring and evaluation should occur at apparently declining populations to determine the extent and causes of decline. Restoration measures should be developed and implemented. (USFWS, 2009)
- Large, stable populations should be designated and core conservation areas for long-term Cheat Mountain salamander survival established. Areas that provide for resiliency to climate change should be considered when designating these areas. (USFWS, 2009)
- Additional habitat delineations should be conducted where known populations occur. Many sites are known from a single location and the extent of the population has not been examined.
- Searches for new populations should be continued. Surveys should be conducted at areas within the known range that have previously not been surveyed in order to determine whether they are occupied and the extent of any potential populations. Surveys should be prioritized in areas with apparently suitable habitat conditions.
- Genetic studies should be completed that look at genetic diversity across the species' range and connectedness of existing populations. Populations that are genetically unique and important to the long-term conservations of the species should be identified. (USFWS, 2009)
- Efforts to address habitat fragmentation (e.g. from roads, trails, rights-of-way) should be undertaken and methods to restore and reconnect Cheat Mountain salamander populations should be evaluated and implemented. (USFWS, 2009).
- Landscape-level habitat evaluation and restoration of red spruce and spruce-northern hardwood habitats should be continued and enhanced. Cheat Mountain salamander distribution and habitat requirements should be considered as part of these efforts. (USFWS, 2009)
- Efforts to works with private landowners to address potential habitat loss should be continued and, where possible, opportunities to develop conservation easements or purchase occupied habitats from willing sellers should be pursued. (USFWS, 2009)
- The threats posed by Chytridiomycosis, climate change, and acid precipitation/deposition should be monitored and long-term management plans and response efforts to address these threats should be developed and implemented. (USFWS, 2009)

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SPECIES ACCOUNT: *Rana draytonii* (California red-legged frog)

Species Taxonomic and Listing Information

Commonly-used Acronym: CRF, CRLF

Listing Status: Threatened; (61 FR 25813).

Physical Description

The California red-legged frog (Rana draytonii) is the largest native frog in the western United States. Adult females attain a significantly longer body length than males (138 millimeters [mm] [5.4 inches (in.)] versus 116 mm [4.5 in.] snout-urostyle length). The posterior abdomen and hind legs of adults are often red or salmon pink; the back is characterized by small black flecks and larger irregular dark blotches with indistinct outlines on a brown, gray, olive, or reddish-brown background color. Dorsal spots usually have light centers. Dorsolateral folds (the ridges of skin along the back) are prominent. Larvae (tadpoles) range from 14 to 80 mm (0.6 to 3.1 in.) in length, and the background color of the body is dark brown or olive with darker spots. A line of very small, indistinct gold-colored spots becomes the dorsolateral fold (USFWS 2002).

Taxonomy

Until recently, the red-legged frog was recognized as two conspecific subspecies: Rana aurora aurora and Rana aurora draytonii. Recent genetic analysis of the Rana aurora/draytonii complex has concluded that the two Rana aurora subspecies are in fact separate species. Separate species status was originally proposed for R. aurora and R. draytonii by Baird and Girard in 1852, but they were later reclassified as a single species with two subspecies. R. draytonii differs from R. aurora, the Northern red-legged frog, both physically and behaviorally. Adult R. draytonii tend to be larger and longer (35 to 40 mm [1.4 to 1.6 in.]) than adult R. aurora and have dorsal spots with usually lighter centers. R. draytonii has paired vocal sacs and typically calls from the air, while R. aurora lacks vocal sacs and typically calls from underwater. Based on the genetic analyses, the herpetological community, academic and governmental researchers, and biologists have accepted the raise to species level and nomenclature change for the California red-legged frog (74 FR 19184). Several other morphological and behavioral characteristics differentiate the two species of red-legged frogs. Female California red-legged frogs deposit egg masses on emergent vegetation so that the masses float on the surface of the water, although biologists from the East Bay Regional Park District have seen submerged egg masses throughout the egg development stage on numerous occasions. Northern red-legged frogs also attach their eggs to emergent vegetation, but the mass is submerged. California red-legged frogs breed from November through early April, and northern red-legged frogs breed from January through March (USFWS 2002). The California red-legged frog is found in central California, from Marin County, California, south to northern Baja California, Mexico, and in isolated drainages in the Sierra Nevada, northern Coast, and northern Transverse Ranges, while the northern red-legged frog ranges from Vancouver Island, British Columbia, Canada, south along the Pacific coast, west of the Cascade ranges to northern California. Some red-legged frogs found in the intervening areas (southern Del Norte to northern Marin County along the Coast Range), exhibit intergrade characteristics of both subspecies. The two species, and intergrades of the species, may occur together in some areas such as the vicinity of Point Reyes National Seashore in Marin County, and portions of Sonoma County (USFWS 2002).

Historical Range

It is believed that before the arrival of Europeans on the west coast of North America, the California red-legged frog was common in coastal habitats from the vicinity of Point Reyes National Seashore, Marin County, California, and inland from the vicinity of Redding, Shasta County, California, southward to northwestern Baja California, Mexico. Historically, the California red-legged frog was known from 46 counties but the taxon is now extirpated from 24 of these (USFWS 2002).

Current Range

The California red-legged frog is now known only from isolated localities in the Sierra Nevada, northern Coast, and northern Transverse Ranges. It is believed to be nearly extirpated from the southern Transverse and Peninsular ranges. This species is still common in the San Francisco Bay Area (including Marin County) and along the central coast. Additional populations are also present in Baja California, Mexico. The current range of the species falls in eight recovery units, which includes the following regions (north to south): Sierra Nevada Foothills and Central Valley; North Coast Range Foothills and Western Sacramento River Valley; North Coast and North San Francisco Bay; South and East San Francisco Bay; Central Coast; Diablo Range and Salinas Valley; Northern Transverse Ranges and Tehachapi Mountains; and Southern Transverse and Peninsular Ranges (USFWS 2002).

Critical Habitat Designated

Yes; 3/17/2010.

Legal Description

On, March 17, 2010, the U.S. Fish and Wildlife Service (Service) designated revised critical habitat for the California red-legged frog (Rana draytonii) under the Endangered Species Act of 1973, as amended (Act). In total, approximately 1,636,609 acres (ac) (662,312 hectares (ha)) of critical habitat in 27 California counties fall within the boundaries of the final revised critical habitat designation.

Critical Habitat Designation

Approximately 1,636,609 ac (662,312 ha) of critical habitat is designated for the California red-legged frog in 48 units that we proposed as revised critical habitat.

BUT-1, Hughes Place Pond This unit consists of approximately 5,294 ac (2,142 ha) and is located in east-central Butte County, east of State Highway 70 and west of OrovilleQuincy Highway. This unit is mapped entirely from occurrences recorded subsequent to the time of listing, but based on life history and population dynamics of the species the area was most likely occupied at the time of listing. The unit is essential for the conservation of the species because the area contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), contains upland habitat for foraging and dispersal activities (PCE 3 and PCE 4), and is currently occupied by the species. This unit encompasses one of six extant Sierra Nevada foothill populations identified since the time of listing and is located in the easternmost portion of the species' historical range. This unit would form one of the core areas for the species and would assist in maintaining the distribution of the species within the Sierra Nevada Mountains. This unit represents the California red-legged frog's adaptation to a wide range of habitat and ecological conditions, and contains high-quality habitat. Land ownership within this unit consists of approximately 3,256 ac (1,318 ha) of Federal land, 281 ac (114 ha) of State land, and 1,757 ac (711 ha) of private land.

The essential features in this unit may require special management considerations or protection due to necessary wildland fire suppression activities, which may dewater aquatic habitats and thereby result in the desiccation of egg masses or direct death of adults from water drafting; timber harvest activities; and predation by nonnative species. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

YUB-1, Little Oregon Creek This unit consists of approximately 6,322 ac (2,558 ha) of land and is located in northeastern Yuba County, north of Marysville Road and south of La Porte Road. YUB-1 is mapped entirely from records identified since the time of listing, but based on life history and population dynamics of the species the area was most likely occupied at the time of listing. The unit is considered essential for the conservation of the species because it contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), contains upland habitat for foraging and dispersal activities (PCE 3 and PCE 4), and is currently occupied by the species. YUB-1 is one of six known extant Sierra Nevada foothill populations and is located in the easternmost portion of the species' historical range. This unit would form one of the core areas for the species and would assist in maintaining the distribution of the species within the Sierra Nevada Mountains. This unit represents the California red-legged frog's adaptation to a wide range of habitat and ecological conditions, is known to be occupied, and contains high-quality habitat. This unit consists of Federal (2,494 ac (1,009 ha)) and private (3,828 ac (1,549 ha)) lands. The essential features in this unit may require special management considerations or protection due to necessary wildland fire suppression activities, which may dewater aquatic habitats and thereby result in the desiccation of egg masses or direct death of adults from water drafting; timber harvest activities; and predation by nonnative species. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

NEV-1, Sailor Flat This unit is comprised of approximately 8,285 ac (3,353 ha) of land and is located in central Nevada County, approximately 3 mi (5 km) northeast of Nevada City, south of Tyler Foote Road and north of State Highway 20. NEV-1 is mapped entirely from occurrences recorded subsequent to the time of listing, but based on life history and population dynamics of the species the area was most likely occupied at the time of listing. The unit is considered essential for the conservation of the species because it contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), contains upland habitat for foraging and dispersal activities (PCE 3 and PCE 4), and is occupied by the species. NEV-1 is one of six known extant Sierra Nevada foothill populations and is located in the easternmost portion of the species' historical range. This unit would form one of the core areas for the species and would assist in maintaining the distribution of the species within the Sierra Nevada Mountains. This unit represents the California red-legged frog's adaptation to a wide range of habitat and ecological variability, is currently known to be occupied, and contains high-quality habitat. This unit consists of Federal (3,171 ac (1,283 ha)), State (12 ac (5 ha)) and private (5,102 ac (2,065 ha)) lands. The essential features in this unit may require special management considerations or protection due to necessary wildland fire suppression activities, which may dewater aquatic habitats and thereby result in the desiccation of egg masses or direct death of adults from water drafting; timber harvest activities; and predation by nonnative species. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

PLA-1, Michigan Bluff This unit is comprised of approximately 1,243 ac (503 ha) of land and is located in central Placer County Nevada County, approximately 4 mi (6 km) east northeast of Foresthill. Unit PLA-1 is mapped entirely from occurrences recorded subsequent to listing, but based on life history and population dynamics of the species the area was most likely occupied at the time of listing. The unit is considered essential for the conservation of the species because it contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), contains upland habitat for foraging and dispersal activities (PCE 3 and PCE 4), and is occupied by the species. PLA-1 is one of six known extant Sierra Nevada foothill populations and is located in the easternmost portion of the species' historical range. This unit would form one of the core areas for the species and would assist in maintaining the distribution of the species within the Sierra Nevada Mountains. This unit represents the California red-legged frog's adaptation to a wide range of habitat and ecological variability, is currently known to be occupied, and contains high-quality habitat. This unit consists of Federal (814 ac (329 ha)) and private (430 ac (174 ha)) lands. The essential features in this unit may require special management considerations or protection due to necessary wildland fire suppression activities, which may dewater aquatic habitats and thereby result in the desiccation of egg masses or direct death of adults from water drafting; timber harvest activities; and predation by nonnative species. Please see the ''Special Management Considerations or Protection'' section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

ELD-1, Spivey Pond This unit is comprised of approximately 5,471 ac (2,214 ha) of land and is located in central El Dorado County, south of State Highway 50 and east of Newton Road. ELD-1 is mapped entirely from occurrences recorded subsequent to listing. However, records at this location were first reported 1 year after listing (1997). Based on the number of mature, reproducing adults and nonreproducing juveniles, we have determined that this site was occupied at the time of listing. This unit contains features essential for the conservation of the species, including aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2) and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4), and is occupied by the species. ELD-1 is 1 of 6 known extant Sierra Nevada foothill populations and is located in the easternmost portion of the species' historical range. This unit would form one of the core areas for the species and would assist in maintaining the distribution of the species within the Sierra Nevada Mountains. This unit represents the California red-legged frog's adaptation to a wide range of habitat and ecological variability, is currently known to be occupied, and contains high-quality habitat. The unit consists of Federal (705 ac (285 ha)) land and private (4,766 ac (1,929 ha)) lands. The essential features in this unit may require special management considerations or protection due to necessary wildland fire suppression activities, which may dewater aquatic habitats and thereby result in the desiccation of egg masses or direct death of adults from water drafting; timber harvest activities; and predation by nonnative species. Snows Quarry does not contain the PCEs, and we have removed it from this final designation of revised critical habitat. However, due to technical mapping constraints we did not physically remove the area from the map depicting unit ELD-1. A portion of the lands containing features essential to the conservation of the California redlegged frog in Unit ELD-1 have been excluded from critical habitat designation under section 4(b)(2) of the Act (see Application of Section 4(b)(2) of the Act section below).

CAL-1, Young's Creek This unit is comprised of approximately 2,764 ac (1,119 ha) of land and is located in northwestern Calaveras County, north of State Highway 26 and south of Paloma Road. CAL-1 is mapped entirely from occurrences recorded subsequent to the time of listing and based on life history and population dynamics of the species the area was most likely occupied at the time of listing. The unit is essential for the conservation of the species because it contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4), and is occupied by the species. This unit encompasses one of six known extant Sierra Nevada foothill populations identified since the time of listing and is located in the easternmost portion of the species historical range. This unit would form one of the core areas for the species and would assist in maintaining the distribution of the species within the Sierra Nevada Mountains. This unit represents the California red-legged frog’s adaptation to a wide range of habitat and ecological variability, is currently known to be occupied, and contains high-quality habitat. The unit consists entirely of private land. The essential features in this unit may require special management considerations or protection due to necessary wildland fire suppression activities, which may dewater aquatic habitats and thereby result in the desiccation of egg masses or direct death of adults from water drafting; overgrazing of land; and predation by non-native species. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

MEN-1, Mills Creek This unit is comprised of approximately 21,814 ac (8,828 ha) of land and is located along the coast north and west of Manchester, California, including the majority of the Mills Creek watershed in Mendocino County. MEN-1 contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). The records within the unit were identified subsequent to listing as northern Mendocino County was thought to be outside the known range of the species. Based on life history and populations dynamics of the species this area was most likely occupied at the time of listing. Subsequent genetic research has confirmed the species occurs in this part of Mendocino County (Shaffer et al. 2004, p. 2676). This unit is currently occupied and is essential to the conservation of the species because it contains permanent and ephemeral aquatic habitats consisting of streams and natural and manmade ponds surrounded by emergent vegetation and marshland with upland comprised of forested timber that provides for breeding and other upland areas for dispersal, shelter, and foraging. The unit also contains freshwater pond and stream habitats associated with upland dune complexes near the coast. Additionally, the unit represents the northernmost extent of the species’ range along the coast of California and may be genetically significant to the species (Shaffer et al. 2004, p. 2676). The unit consists of approximately 86 acres (ac) (35 hectares (ha)) of Federal land; 296 ac (120 ha) of State land; 92 ac (37 ha) of Tribal land; and 21,340 ac (8,636 ha) of private land. The physical and biological features essential to the conservation of California red-legged frog in the MEN-1 unit may require special management considerations or protection due to nonnative animal species, habitat alteration from invasive plant species, timber harvesting which may alter aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or adults due to habitat modification and predation. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

SON-1, Annadel This unit is comprised of approximately 1,564 ac (633 ha) of land, is located in Annadel State Park southeast of Santa Rosa, California, in Sonoma County, and contains features that are essential for the conservation of the species. SON-1 was known to be occupied at the time of listing and is currently occupied. SON-1 contains aquatic habitat for breeding and nonbreeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities

(PCE 3 and PCE 4). The unit contains permanent and ephemeral aquatic habitat consisting of marshland ponds with emergent vegetation surrounded by bulrush (Scirpus spp.) and cattail (Typha spp.), annual and perennial grasslands, oak forest, and Douglas-fir forests, which allow for breeding and non-breeding pond activities. Upland areas in the unit provide for dispersal, shelter, and foraging. The unit provides for connectivity between populations farther south in the northbay area (area north of San Francisco Bay), and contains high-quality, protected habitat. The unit also represents the distribution of the California red-legged frog in the northern interior Coast Range. The unit consists of State (1,157 ac (468 ha)) and private (407 ac (165 ha)) lands and is mapped from occurrences recorded at the time of listing and subsequent to the time of listing. The physical and biological features essential to the conservation of California red-legged frog in the SON-1 unit may require special management considerations or protection due to nonnative animal species, habitat alteration from invasive plant species, and recreational use which may alter aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or adults due to habitat modification and predation. Please see the ‘‘Special Management Considerations or Protection’’ section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

SON-2, Sonoma Mountain This unit is comprised of approximately 4,932 ac (1,996 ha) of land and is located east of Petaluma, California, in the Sonoma Mountains in Sonoma County. SON-2 is mapped from occurrences recorded at the time and subsequent to the time of listing and is currently occupied. This unit is essential to the conservation of the species because it contains permanent and ephemeral breeding and nonbreeding aquatic habitats (PCE 1 and PCE 2) consisting of natural and manmade ponds surrounded by emergent vegetation and marshland with appropriate upland areas for dispersal, shelter, and foraging (PCE 3 and PCE 4). The unit also provides for connectivity between populations farther north and south in the northbay (Counties North of San Francisco Bay), and contains high-quality habitat. The unit also represents the distribution of the California red-legged frog in the northern interior Coast Range. The unit consists entirely of private land. The physical and biological features essential to the conservation of California red-legged frog in the SON-2 unit may require special management considerations or protection due to predation by nonnative species, and habitat alteration from invasive plant species, which may alter aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or adults due to habitat modification. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

SON-3, Petaluma This unit is comprised of approximately 2,230 ac (902 ha) of land and is located southwest of Petaluma, California, near West Petaluma Regional Park in Sonoma County. SON-3 is mapped entirely from occurrences recorded subsequent to the time of listing, but based on life history and population dynamics of the species the area was most likely occupied at the time of listing. The unit is essential for the conservation of the species because it provides for connectivity between populations farther west in the northbay, and contains high-quality habitat. The unit also represents the distribution of the California red-legged frog in the northern interior Coast Range. This unit also contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). SON-3 is currently occupied and contains permanent and ephemeral aquatic habitats comprised of manmade ponds and connecting streams surrounded by riparian and grassland habitat that provide for breeding, and upland areas for dispersal, shelter, and foraging. The unit consists of local government lands (105 ac (42 ha)) and private lands (2,125 ac (860 ha)). The physical and biological features essential to the conservation of California red-legged frog in the SON-3 unit may require special management considerations or protection due to nonnative animal species, habitat alteration from invasive plant species, and recreational use which may alter aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or adults due to habitat modification and predation. Please see the ‘‘Special Management Considerations or Protection’’ section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

NAP-1, Wragg Creek This unit is comprised of approximately 2,524 ac (1,022 ha) of land, is located in east-central Napa County, is bisected by State Highway 128, and lies largely to the west of State Highway 121. NAP-1 was known to be occupied at the time of listing, is currently occupied, and contains the features that are essential for the conservation of the species. The unit contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). The unit contains permanent and ephemeral aquatic habitats suitable for breeding and upland areas for dispersal, shelter, and food. The unit provides for connectivity between populations northwest of the northbay; represents the northern extent of the species’ range in the northern interior Coast Range; and contains high-quality habitat. The unit consists entirely of private land and is mapped from occurrences recorded at the time of listing and subsequent to the time of listing. The physical and biological features essential to the conservation of California red-legged frog in the NAP-1 unit may require special management considerations or protection due to predation by nonnative species and habitat disturbance, which may alter aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or adults due to habitat modification. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

MRN-1, Estero This unit is comprised of approximately 7,840 ac (3,173 ha) of land and is located in northwestern Marin County, west of State Highway 1 along the Estero de San Antonio. MRN- 1 is occupied and contains occurrences recorded at the time of listing and subsequent to the time of listing. The area is occupied by the species, and contains features essential to the conservation of the species because it contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). MRN-1 provides for connectivity between populations in the northbay region. The unit also represents the distribution of the California red-legged frog in the northbay coastal area. The unit contains permanent and ephemeral aquatic habitats, such as shallow and deep pools, as well as ephemeral and permanent drainages surrounded by grasslands, emergent and other riparian vegetation that provide for aquatic breeding and non-breeding, and upland areas for dispersal, shelter, and foraging. The unit consists of 11 ac (4 ha) of State land and 7,829 ac (3,168 ha) of private land. The physical and biological features essential to the conservation of California red-legged frog in the MRN- 1 unit may require special management considerations or protection due to overgrazing of aquatic and riparian habitats, introduction of exotic vegetation, and urban development, which may alter aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or adults due to habitat modification. Please see the ‘‘Special Management Considerations or Protection’’ section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

MRN-2, Salmon Creek This unit is comprised of approximately 22,559 ac (9,129 ha) of land and is located in north-central Marin County, east of State Highway 1 and north of Point Reyes Petaluma Road. MRN-2 is occupied and contains occurrences recorded subsequent to the time of listing, but based on life history and population dynamics of the species the area was most likely occupied at the time of listing. The area is essential to the conservation of the species because it contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), contains upland habitat for foraging and dispersal activities (PCE 3 and PCE 4), and is occupied by the species. MRN-2 provides for connectivity between populations in the northbay region of the species' coastal range. The unit also represents the distribution of the California red-legged frog in the northbay coastal area. The unit contains permanent and ephemeral aquatic habitats suitable for breeding; upland areas for dispersal, shelter, and food; and high-quality habitat. The unit consists of 1,046 ac (423 ha) of local government land and 21,513 ac (8,706 ha) of private land. The physical and biological features essential to the conservation of California red-legged frog in the MRN- 2 unit may require special management considerations or protection due to nonnative animal species, habitat alteration from invasive plant species, and recreational use which may alter aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or adults due to habitat modification and predation. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

MRN-3, Point Reyes Peninsula This unit is comprised of approximately 33,600 ac (13,598 ha) of land and is located in western Marin County, west of State Highway 1. MRN- 3 contains the features that are essential for the conservation of the species. The unit contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). MRN-3 was known to be occupied at the time of listing and is currently occupied. The unit contains high-quality permanent and ephemeral aquatic habitats suitable for breeding, and upland areas for dispersal, shelter, and food. The unit provides for connectivity between populations farther north and inland and represents the southern portion of the geographic range of the California red-legged frog within the northbay coastal region. The unit consists of Federal land (National Park Service) (31,403 ac (12,709 ha)), State land (147 ac (60 ha)), and private land (2,050 ac (830 ha)) and is mapped from occurrences recorded at the time of listing and subsequent to the time of listing. The physical and biological features essential to the conservation of California red-legged frog in the MRN- 3 unit may require special management considerations or protection due to predation by non-native species and to overgrazing of aquatic and riparian habitats which may alter aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or adults due to habitat modification. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

SOL-1, Sky Valley This unit is comprised of approximately 11,971 ac (4,845 ha) of land and is located in southwestern Solano County and a portion of extreme southeastern Napa County, south of Interstate 80 and west of Interstate 680. SOL-1 contains the features that are essential for the conservation of the species. The unit contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). Unit SOL- 1 was known to be occupied at the time of listing and is currently occupied. The unit contains high-quality permanent and ephemeral aquatic habitats suitable for breeding, and upland areas for dispersal, shelter, and food. The designation of this unit is expected to prevent further fragmentation of habitat in this portion of the species' range and represents the southern extent of the species in the interior Coast Range north of the Suisun Bay. The unit consists entirely of private land and is mapped from occurrences recorded at the time of listing and subsequent to the time of listing. The physical and biological features essential to the conservation of California red-legged frog in the SOL-1 unit may require special management considerations or protection due to overgrazing of aquatic and riparian habitats, and removal and alteration of habitat due to urbanization, which may alter or eliminate aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses adults. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

SOL-2, Jameson Canyon This unit is comprised of approximately 3,360 ac (1,360 ha) of land and is located in southwestern Solano County and a portion of extreme southeastern Napa County, south of Interstate 80 and west of Interstate 680. SOL-2 is mapped entirely from records found subsequent to the time of listing and is currently occupied, but based on life history and population dynamics of the species the area was most likely occupied at the time of listing. SOL-2 is essential for the conservation of the species because it provides connectivity to adjacent units to the south in the interior Coast Range north of the Suisun Bay and is expected to prevent further fragmentation of habitat in this portion of the species' range. This unit also contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). The unit contains high-quality permanent and ephemeral aquatic habitats consisting of stream and plunge pools as well as large freshwater marsh surrounded by open grassland, willow (Salix spp.), and oak (Quercus agrifolia) that provide for breeding, and upland areas for dispersal, shelter, and foraging. The unit consists entirely of private land. The physical and biological features essential to the conservation of California red-legged frog in the SOL-2 unit may require special management considerations or protection due to nonnative animal species, over grazing of habitat, urbanization, habitat alteration from invasive plant species, and recreational use which may alter aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or adults due to habitat modification and predation. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

SOL-3, American Canyon This unit is comprised of approximately 4,597 ac (1,861 ha) of land and is located in southwestern Solano County and a portion of extreme southeastern Napa County, north of Interstate 80 and south of Highway 12. SOL-3 was known to be occupied at the time of listing and is currently occupied. SOL-3 contains the features that are essential for the conservation of the species. The unit contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). The unit contains high-quality permanent and ephemeral aquatic habitats consisting of pools, stream, and spring habitat surrounded by riparian tree species and annual grasslands that provide for breeding, and upland areas for dispersal, shelter, and foraging. The designation of this unit is expected to prevent further fragmentation of habitat in this portion of the species' range and provides connectivity to other units farther north and south in the interior Coast Range north of the Suisun Bay. The unit consists of 1,087 ac (440 ha) of local nonprofit ownership and 3,510 ac (1,421 ha) of private land and is mapped from occurrences recorded at the time of listing and subsequent to the time of listing. The physical and biological features essential to the conservation of California red-legged frog in the SOL-3 unit may require special management considerations or protection due to overgrazing of aquatic and riparian habitats, and loss and alteration of habitat due to urbanization, which may alter or eliminate aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or adults. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

CCS-1, Berkeley Hills This unit is comprised of approximately 13,845 ac (5,603 ha) of land and is located in western Contra Costa County, south of Alhambra Valley Road and north of Bear Creek Road. CCS-1 contains the features that are essential for the conservation of the species. The unit contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). CCS-1 was known to be occupied at the time of listing, is currently occupied, and contains high-quality permanent and ephemeral aquatic habitats suitable for breeding and upland areas for dispersal, shelter, and food. The designation of this unit is expected to prevent further fragmentation of habitat in this portion of the species' range. The unit also represents the northern extent of the California red-legged frog in the eastbay region (area east of San Francisco Bay). The unit consists of private (4,010 ac (1,623 ha)) and local government (9,835 ac (3,980 ha)) lands. The physical and biological features essential to the conservation of California red-legged frog in the CCS-1 unit may require special management considerations or protection due to predation by nonnative species, and removal and alteration of habitat due to urbanization, and overgrazing of aquatic and riparian habitats, which may alter aquatic and upland habitats and thereby result in the direct or indirect loss of egg masses or adults due to habitat modification. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

CCS-2, Mount Diablo This unit is comprised of two subunits (CCS-2A and CCS-2B), totals approximately 48,697 ac (19,707 ha) of land, and is located in eastern Contra Costa County and northeastern Alameda County, north of Highway 580. Unit CCS-2A (4,227 ac (1,711 ha)) and CCS-2B (44,470 ac (17,996 ha)) contain the features that are essential for the conservation of the species. The subunits contain aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). Subunits CCS-2A and CCS-2B were known to be occupied at the time of listing and are currently occupied. The subunits contain permanent and ephemeral aquatic habitats suitable for breeding, and upland areas for dispersal, shelter, and food, and they provide for connectivity between populations farther south in the interior Coast Range. The Subunit CCS-2A also represents the northern extent of the California red-legged frog in the interior Coast Range. Subunit CCS-2B contains some of the highest concentrations of California red-legged frog and frog habitat and could serve as a source for potential reintroduction efforts. Subunit CCS-2A consists of State (3,006 ac (1,217 ha)), local government (277 ac (112 ha)), and private (944 ac (382 ha)) land, and subunit CCS-2B consists of State (4,059 ac (1,643 ha)), local government (3,088 ac (1,250 ha)), and private (37,322 ac (15,104 ha)) lands. Both subunits are mapped from occurrences recorded at the time of listing and subsequent to the time of listing. The physical and biological features essential to the conservation of California red-legged frog in CCS-2 may require special management considerations or protection due to predation by nonnative species, urbanization, overgrazing of aquatic and riparian habitats, and erosion and siltation due to flooding, which may alter aquatic and upland habitats and thereby result in the direct or indirect loss of egg masses or adults. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations. A portion of the lands containing features essential to the conservation of the California red-legged frog in Unit CCS- 2 have been excluded from critical habitat designation under section 4(b)(2) of the Act (see Application of Section 4(b)(2) of the Act section below).

ALA-1A, Dublin Canyon This subunit is one of two subunits for the Alameda County area and is comprised of approximately 3,650 ac (1,477 ha) of land and is located in northwestern Alameda County and southern Contra Costa County, north of Highway 580 and west of Dublin, California. Unit ALA-1A contains the features that are essential for the conservation of the species. The subunit contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). ALA-1A was known to be occupied at the time of listing and is currently occupied. The subunit contains permanent and ephemeral aquatic habitats that provide for breeding that are comprised of manmade stock ponds and natural streams with emergent vegetation, willows (Salix spp.), or are surrounded by riparian vegetation, grasslands and oak forest. These aquatic habitats also have adjacent upland areas for dispersal, shelter, and foraging opportunities. The subunit provides for connectivity between populations farther south in the eastbay foothills. The unit also represents the southernmost distribution of the California redlegged frog and its habitat in the east bay region. The subunit consists entirely of local government land (603 ac (244 ha)) and private land (3,047 ac (1,233 ha)) and is mapped from occurrences recorded at the time of listing and subsequent to the time of listing. The physical and biological features essential to the conservation of California red-legged frog in the ALA- 1A subunit may require special management considerations or protection due to removal and alteration of habitat due to urbanization, alteration of aquatic and riparian habitats, dumping, and erosion and siltation of ponded habitat, which may alter aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or adults. Please see the ‘‘Special Management Considerations or Protection’’ section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

ALA-1B, Cook Canyon This subunit is the second of two subunits and is comprised of approximately 10,159 ac (4,111 ha) of land and is located in northwestern Alameda County, south of Highway 580. Unit ALA-1B contains the features that are essential for the conservation of the species. The subunit contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). ALA-1B was known to be occupied at the time of listing and is currently occupied. The subunit contains permanent and ephemeral aquatic habitats comprised of manmade stock ponds and natural streams with emergent vegetation, willows (Salix spp.) surrounded by riparian vegetation, grasslands and oak forest that provide for breeding, and upland areas for dispersal, shelter, and foraging opportunities. The subunit provides for connectivity between populations farther north in the eastbay foothills. The subunit also represents the southern-most distribution of the California red-legged frog and its habitat in the east bay region. The subunit consists of local government land (3,667 ac (1,484 ha)) and private land (6,492 ac (2,627 ha)) and is mapped from occurrences recorded at the time of listing and subsequent to the time of listing. The physical and biological features essential to the conservation of California red-legged frog in the ALA-1B subunit may require special management considerations or protection due to removal and alteration of habitat due to urbanization, alteration of aquatic and riparian habitats, and erosion and siltation of ponded habitat, which may result in direct or indirect loss of egg masses or adults. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

ALA-2, Arroyo Valle This unit is comprised of approximately 153,624 ac (62,169 ha) of land and is located in southwestern Alameda County, south of Highway 580 at Altamont Pass southeast into San Joaquin County and southwest into Santa Clara County near Arroyo Hondo and Calaveras Reservoir. Unit ALA-2 contains the features that are essential for the conservation of the species. The unit contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). ALA-2 was known to be occupied at the time of listing and is currently occupied. The unit contains permanent and ephemeral aquatic habitats comprised of natural ponds and streams and manmade stock ponds with emergent vegetation, willows (Salix spp.) surrounded by riparian vegetation, grasslands and oak forest that provide for breeding, and upland areas for dispersal, shelter, and foraging opportunities. The unit provides for connectivity between populations farther north and south in the interior Coast Range. The unit consists of Federal (6,892 ac (2,789 ha)), State (3,932 ac (1,591 ha)), local government (39,525 ac (15,995 ha)), and private (103,276 ac (41,794 ha)) lands and is mapped from occurrences recorded at the time of listing and subsequent to the time of listing. The physical and biological features essential to the conservation of California red-legged frog in the ALA-2 unit may require special management considerations or protection due to urbanization, alteration of aquatic and riparian habitats, and erosion and siltation of ponded habitat, which may alter aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or adults. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

SNM-1, Cahill Ridge This unit is comprised of approximately 34,952 ac (14,145 ha) of land and is located in north central San Mateo County, west of Interstate 280 and south of Pacifica, California. SNM- 1 contains the features that are essential for the conservation of the species. The unit contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). SNM-1 was known to be occupied at the time of listing and is currently occupied. The unit contains high-quality permanent and ephemeral aquatic habitats consisting of ponds and streams surrounded by riparian and emergent vegetation that provides for breeding and upland areas for dispersal, shelter, and food. The unit represents the only unit in the San Francisco peninsula, and would assist in maintaining the distribution of the California red-legged frog population within the San Francisco area, and provide connectivity to units farther south into Santa Cruz County. The unit consists of State (12 ac (5 ha)), private (32,844 ac (13,292 ha)), and local government (2,096 ac (848 ha)) lands and is mapped from occurrences recorded at the time of listing and subsequent to the time of listing. The physical and biological features essential to the conservation of California red-legged frog in the SNM-1 unit may require special management considerations or protection due to development and nonnative invasive plants, which may alter aquatic and upland habitats and thereby result in the direct or indirect loss of egg masses or adults. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

SNM-2, Pescadero This unit is comprised of approximately 96,138 ac (38,906) of land and is located in southwestern San Mateo County, south of Tunitas Creek, west of State Route 35 south into Santa Cruz County near Big Basin Redwoods State Park. Unit SNM-2 contains the features that are essential for the conservation of the species. The unit contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). SNM-2 was known to be occupied at the time of listing and is currently occupied. The unit contains highquality permanent and ephemeral aquatic habitats consisting of ponds and streams surrounded by riparian and emergent vegetation that provides for breeding and upland areas for dispersal, shelter, and food. The unit provides connectivity to units farther north toward San Francisco and south into Santa Cruz County. The unit consists of Federal (406 ac (164 ha)), State (4,004 ac (1,620 ha)), local government (6,332 ac (2,563 ha)), and private (85,396 ac (34,559 ha)) lands and is mapped from occurrences recorded at the time of listing and subsequent to the time of listing. The physical and biological features essential to the conservation of California red-legged frog in the SNM-2 unit may require special management considerations or protection due to development and nonnative invasive plants, which may alter aquatic and upland habitats and thereby result in the direct or indirect loss of egg masses or adults. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

STC-1, Can˜ ada de Pala This unit is comprised of approximately 52,283 ac (21,158 ha) of land and is located in north-central Santa Clara County, south of Calaveras Reservoir near Los Buellis Hills south along the ridgeline east of Santa Clara Valley to Anderson Lake and Henry Coe State Park. Unit STC-1 contains the features that are essential for the conservation of the species. The unit contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2) and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). STC-1 was known to be occupied at the time of listing, is currently occupied, and contains high-quality permanent and ephemeral aquatic habitats consisting of artificial and natural ponds and streams surrounded by emergent vegetation, grasslands and oak woodlands that provide for breeding, and upland areas for dispersal, shelter, and food. The designation of this unit is expected to assist in preventing further fragmentation of habitat in this portion of the species' range and represents a connectivity corridor between units farther north into Contra Costa County and south into Merced and San Benito Counties. This unit consists of Federal (37 ac (15 ha)), local government (8,451 ac (3,420 ha)), and private (43,795 ac (17,723 ha)) lands and is mapped from occurrences recorded at the time of listing and subsequent to the time of listing. The physical and biological features essential to the conservation of California red-legged frog in the STC-1 unit may require special management considerations or protection due to predation by nonnative species, urbanization, the presence of exotic species, siltation and erosion of ponded habitat, and overgrazing of aquatic and riparian habitats, which may alter aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or adults. Please see the ''Special Management Considerations or Protection'' section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

STC-2, Wilson Peak This unit is comprised of approximately 204,718 ac (82,846 ha) of land and is located in southeastern Santa Clara County to western Stanislaus County down to northern San Benito County from Henry Coe State Park south to Mount Ararat (Merced County) and Mariposa Peak (San Benito County) to San Felipe (Santa Clara County). Unit STC-2 contains the features that are essential for the conservation of the species. The unit also contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). STC-2 was known to be occupied at the time of listing and is currently occupied. The unit contains high-quality permanent and ephemeral aquatic habitats suitable for breeding and upland areas for dispersal, shelter, and food. The designation of this unit is expected to prevent further habitat fragmentation; provide connectivity to units farther north in Santa Clara, Alameda, and Contra Costa Counties; and represents the southern portion of the areas designated within Santa Clara County and east bay. The unit consists of Federal (604 ac (244 ha)), State (53,267 ac (21,556 ha)), local government (74 ac (30 ha)), and private (150,773 ac (61,016 ha)) lands and is mapped from occurrences recorded at the time of listing and subsequent to the time of listing. The physical and biological features essential to the conservation of California red-legged frog in the STC-2 unit may require special management considerations or protection due to predation by nonnative species, and habitat alteration from development activities which may affect aquatic habitats and thereby result in the direct or indirect loss of egg masses, juveniles, or adults. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

SCZ-1, North Coastal Santa Cruz County This unit is comprised of approximately 72,249 ac (29,238 ha) of land and is located along the coastline of northern Santa Cruz County, plus a small area in southern San Mateo County, from approximately Green Oaks Creek to Wilder Creek. The unit includes the following watersheds: Green Oaks Creek, Waddell Creek, East Waddell Creek, Scott Creek, Big Creek, Little Creek, San Vicente Creek, Laguna Creek, and Majors Creek. The unit is mapped from occurrences recorded at the time of listing and subsequent to the time of listing and is currently occupied. SCZ-1 contains the features that are essential for the conservation of the species. The unit also contains aquatic habitat for breeding and nonbreeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). SCZ-1 provides connectivity between occupied sites along the coast and farther inland. In addition, it contains high-quality habitat, indicated by high density of extant occurrences, permanent and ephemeral aquatic habitat suitable for breeding, and accessible upland areas for dispersal, shelter, and food. The unit represents one of two areas designated for critical habitat in Santa Cruz County and is the northern extent of the central coast recovery unit. The unit consists of Federal (226 ac (92 ha)), State (20,562 ac (8,321 ha)), and private (51,460 ac (20,825 ha)) lands. The physical and biological features essential to the conservation of California red-legged frog in the SCZ-1 unit may require special management considerations or protection due to water diversions, which may alter aquatic habitats and thereby result in the direct or indirect loss of egg masses, juveniles, or adults. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations. A portion of the lands containing features essential to the conservation of the California red-legged frog in Unit SCZ 1 have been excluded from critical habitat designation under section 4(b)(2) of the Act (see Application of Section 4(b)(2) of the Act section below).

SCZ-2, Watsonville Slough This unit is comprised of approximately 4,057 ac (1,642 ha) of land and is located along the coastal plain in southern Santa Cruz County, north of the mouth of the Pajaro River and seaward of California Highway 1. It includes locations in the Watsonville Slough system, including all or portions of Gallighan, Hanson, Harkins, Watsonville, Struve, and the West Branch of Struve sloughs. The unit includes portions of the Corralitos Lagoon and Mouth of the Pajaro River watersheds. The unit is mapped from occurrences recorded at the time of listing and subsequent to the time of listing. SCZ-2 contains the features that are essential for the conservation of the species. This unit is currently occupied, and contains permanent and ephemeral aquatic habitat for breeding and nonbreeding activities (PCE 1 and PCE 2), and contains upland habitat for foraging, dispersal activities, and shelter (PCE 3 and PCE 4). SCZ-2 also provides connectivity between occupied sites along the coast and farther inland. The unit consists of Federal (115 ac (46 ha)) and private (3,942 ac (1,595 ha)) lands. The physical and biological features essential to the conservation of California red-legged frog in the SCZ-2 unit may require special management considerations or protection due predation by nonnative species, and due to urbanization and the presence of introduced invasive plants, both of which may alter aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or adults. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

MNT-1, Elkhorn Slough This unit is comprised of approximately 519 ac (210 ha) of land and is located along the coastal plain in northern Monterey County, inland from the town of Moss Landing, and it is mapped from occurrences recorded at the time of listing and subsequent to the time of listing. This unit is currently occupied. The unit includes the eastern edge of the Elkhorn Slough watershed and the western edge of the Strawberry Canyon watershed. MNT-1 contains the features that are essential for the conservation of the species. This unit contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). The designation of MNT-1 is expected to prevent further fragmentation of habitat in this portion of the species' range, contains permanent and ephemeral aquatic habitats suitable for breeding, and contains upland areas for dispersal, shelter, and food. We have determined that these attributes are essential to the conservation of the species. Elkhorn Slough is unique in that it is a large estuary/freshwater slough system not typically found on the California coast. The unit consists entirely of private land. The physical and biological features essential to the conservation of California red-legged frog in the MNT- 1 unit may require special management considerations or protection due to pesticide exposure, trematode infestation, disease, and predation by nonnative species, which may affect aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or adults. Please see the ''Special Management Considerations or Protection'' section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

MNT-2, Carmel River This unit is comprised of approximately 119,492 ac (48,357 ha) of land, is located south and southeast of the city of Monterey, and includes locations in the Carmel River drainage and nearby San Jose Creek. The unit includes the following watersheds and portions of watersheds: the southern portion of Carmel Bay, Carmel Valley, Robinson Canyon, San Jose Creek, Las Garces Creek, Hitchcock Canyon, the western portion of Lower Tularcitos Creek, Klondike Canyon, Black Rock Creek, Pine Creek, Danish Creek, Cachagua Creek, Lower Finch Creek, Bear Canyon, Bruce Fork, and Miller Canyon. It is mapped from occurrences recorded at the time of listing and subsequent to the time of listing. MNT- 2 contains the features that are essential for the conservation of the species. The unit is currently occupied and contains permanent and ephemeral aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging, dispersal activities, and shelter (PCE 3 and PCE 4). The unit is the largest designated within Monterey County. The unit consists of Federal (26,098 ac (10,562 ha)), State (374 ac (151 ha)), local government (1,373 ac (556 ha)), and private (91,647 ac (37,088 ha)) lands. The physical and biological features essential to the conservation of California red-legged frog in the MNT- 2 unit may require special management considerations or protection due to predation by nonnative species, urbanization, and water pumping and diversions, which may alter aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or adults. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

MNT-3, Big Sur Coast This unit is comprised of approximately 27,542 ac (11,146 ha) of land; is located along the Big Sur coastline in Monterey County, approximately from the mouth of the Little Sur River south to McWay Canyon; and includes locations in and around the Big Sur River drainage. The unit includes the following watersheds: Point Sur, Big Sur River, Ventana Creek, Sycamore Canyon, and Partington Creek. This unit was not known to be occupied at the time of listing, but surveys conducted subsequent to the time of listing show that this unit is currently occupied. Based on life history and population dynamics of the species we have determined that the area was most likely occupied at the time of listing. MNT-3 is essential for the conservation of the species because it contains the largest coastal habitat within Monterey Bay region and provides for connectivity to more interior units further north. MNT-3 also contains permanent and ephemeral aquatic habitat for breeding and nonbreeding activities (PCE 1 and PCE 2), and upland habitat for foraging, dispersal activities, and shelter (PCE 3 and PCE 4). MNT-3 is currently occupied by the species. The unit consists of Federal (9,960 ac (4,030 ha)), State (4,245 ac (1,718 ha)), and private (13,338 ac (5,398 ha)) lands. The physical and biological features essential to the conservation of California red-legged frog in the MNT- 3 unit may require special management considerations or protection due to predation by non-native species, urbanization, and water pumping and diversions, which may alter aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or adults. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

SNB-1, Hollister Hills/San Benito River This unit is comprised of approximately 36,294 ac (14,687 ha) of land and is located in northwestern San Benito County in the San Benito River drainage. The unit includes the following watersheds and portions of watersheds: the southern portions of San Justo Reservoir, Northeast Hollister Hills, and Upper Bird Creek; Left Fork Bird Creek; Sulfur Canyon; and the western portions of Arroyo Hondo, Willow Grove School, Paicines Ranch, and Lower Pescadero Creek. It is mapped from occurrences recorded at the time of listing and subsequent to the time of listing near Saint Frances Retreat, San Juan Oaks, Azalea Canyon, Bird Creek, Hollister Hills State Vehicle Recreation Area, Paicines Reservoir, and Tres Pinos Creek. SNB-1 contains the features that are essential for the conservation of the species. The unit contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). SNB-1 also provides essential connectivity between sites on the coast plain and inner Coast Range. SNB-1 is occupied by the species, is expected to prevent further fragmentation of habitat in this portion of the species' range, and contains permanent and ephemeral aquatic habitats suitable for breeding and accessible upland areas for dispersal, shelter, and food. The unit consists of Federal (13 ac (5 ha)), State (3,109 ac (1,258 ha)), and private (33,172 ac (13,424 ha)) lands. The physical and biological features essential to the conservation of California red-legged frog in the SNB-1 unit may require special management considerations or protection due to predation by nonnative species, and habitat disturbance, which may alter aquatic and upland habitats and thereby result in the direct or indirect loss of egg masses or adults. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

SNB-2, Antelope Creek/Upper Tres Pinos Creek This unit is comprised of approximately 17,356 ac (7,024 ha) of land and is located in central San Benito County along the Tres Pinos Creek drainage within the Antelope Creek watershed. This unit was not known to be occupied at the time of listing, but surveys conducted subsequent to the time of listing show that this unit is currently occupied, and based on life history and population dynamics of the species we have determined that the area was most likely occupied at the time of listing. It is mapped from occurrence records in and along Tres Pinos Creek between the confluences of Boulder and Willow Springs Creeks. SNB-2 is essential for the conservation of the species because it provides aquatic habitat for breeding and nonbreeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). SNB-2 is occupied by the species, is expected to prevent fragmentation of habitat in this portion of the species’ range, and contains permanent and ephemeral aquatic habitats suitable for breeding and accessible upland areas for dispersal, shelter, and food. The unit consists entirely of private land. The physical and biological features essential to the conservation of California red-legged frog in the SNB-2 unit may require special management considerations or protection due to predation by nonnative species, overgrazing and trampling of aquatic and upland habitat by feral pigs, and recreational activities, which may alter aquatic and upland habitats and thereby result in the direct or indirect loss of egg masses or adults. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

SNB-3, Pinnacles National Monument This unit is comprised of approximately 63,753 ac (25,800 ha) of land; is located in the Gabilan Range at Pinnacles National Monument, about 3.5 mi (5.6 km) west of the town of San Benito in southern San Benito County; and is mapped from occurrences recorded at the time of listing and subsequent to the time of listing. The unit includes the following watersheds: Gloria Lake, Bickmore Canyon, Sulfur Creek, and George Hansen Canyon. SNB-3 contains the features that are essential for the conservation of the species. The unit contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). SNB-3 is expected to prevent further fragmentation of habitat in this portion of the species’ range; contains permanent and ephemeral aquatic habitat suitable for breeding; contains accessible upland areas for dispersal, shelter, and food; and is occupied by the species. The unit consists of Federal (20,048 ac (8,113 ha)) and private (43,706 ac (17,687 ha)) lands. The physical and biological features essential to the conservation of California red-legged frog in the SNB-3 unit may require special management considerations or protection due to predation by nonnative species, overgrazing and trampling of aquatic and upland habitat by feral pigs, and recreational activities, which may alter aquatic and upland habitats and thereby result in the direct or indirect loss of egg masses or adults. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

SLO-1, Cholame This unit is comprised of approximately 18,018 ac (7,292 ha) of land; and is located in northeastern San Luis Obispo, northwestern Kern, and southwestern Kings Counties; includes locations in the Cholame Creek drainage; and is mapped from occurrences recorded at time of listing and subsequent to the time of listing. The unit includes portions of the following watersheds: the southern portion of Blue Point, the western portion of Jack Canyon, and the eastern portion of Palo Prieto Canyon. SLO-1 contains the features that are essential for the conservation of the species. The unit contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). SLO-1 contains permanent and ephemeral aquatic habitats suitable for breeding; contains accessible upland areas for dispersal, shelter, and food; and is occupied by the species. SLO-1 consists of Federal (169 ac (68 ha)) and private (17,849 ac (7,223 ha)) lands. The physical and biological features essential to the conservation of California red-legged frog in the SLO-1 unit may require special management considerations or protection due to highway construction, overgrazing, and water diversions, which may alter aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or adults. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

SLO-2, Piedras Blancas to Cayucos Creek This unit is comprised of approximately 82,673 ac (33,457 ha) of land and is located along the coast in northwestern San Luis Obispo County from approximately Arroyo de Los Chinos southward to just before but not including Whale Rock Reservoir. The unit includes the following watersheds: Arroyo de los Chinos, Lower Arroyo de la Cruz, Arroyo del Corral, Oak Knoll Creek, Broken Bridge Creek, Pico Creek, Upper San Simeon Creek, Lower San Simeon Creek, Steiner Creek, Upper Santa Rosa Creek, Lower Santa Rosa Creek, and Lower Green Valley Creek. The unit is mapped from occurrences recorded at the time of listing and subsequent to the time of listing. SLO- 2 contains the features that are essential for the conservation of the species. The unit contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). SLO-2 provides connectivity within the Santa Lucia Range, and between this range and the inner Coast Range in San Luis Obispo County. This unit is occupied by the species. The unit contains high-quality habitat, indicated by high density of extant occurrences, permanent and ephemeral aquatic habitats suitable for breeding, and accessible upland areas for dispersal, shelter, and food. The unit consists of Federal (440 ac (178 ha)), State (648 ac (262 ha)), and private (81,585 ac (33,016 ha)) lands. The physical and biological features essential to the conservation of California red-legged frog in the SLO-2 unit may require special management considerations or protection due to predation by nonnative species, water diversion, overgrazing, and urbanization, which may alter aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or adults due to habitat modification. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations. A portion of the lands containing features essential to the conservation of the California red-legged frog in Unit SLO-2 has been excluded from critical habitat designation under section 4(b)(2) of the Act (see Application of Section 4(b)(2) of the Act section below).

SLO-3, Willow and Toro Creeks to San Luis Obispo This unit is comprised of approximately 116,517 ac (47,153 ha) of land and is located near the coast in central San Luis Obispo County and extends about 1.9 mi (3 km) north of the town of Morro Bay southward to just north and east of the city of San Luis Obispo. The unit includes the following watersheds: Old Creek, Whale Rock Reservoir, the southern portion of Hale Creek, Morro Bay, San Luisito Creek, the western and southern portions of Santa Margarita Creek, Choro Reservoir, Stenner Lake, Reservoir Canyon, Trout Creek, and Big Falls Canyon. The unit is mapped from occurrences recorded at the time of listing and subsequent to the time of listing. SLO-3 contains the features that are essential for the conservation of the species. The unit is currently occupied and contains permanent and ephemeral aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging, dispersal, and shelter (PCE 3 and PCE 4). SLO-3 provides connectivity within the Santa Lucia Range, and between this range and the inner Coast Range in San Luis Obispo County. This unit consists of Federal (29,104 ac (11,778 ha)), State (5,737 ac (2,322 ha)) and private (81,676 ac (33,053 ha)) lands. The physical and biological features essential to the conservation of California red-legged frog in the SLO-3 unit may require special management considerations or protection due to predation by nonnative species, water diversion, overgrazing, and urbanization, which may alter aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or adults due to habitat modification. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations. A portion of the lands containing features essential to the conservation of the California red-legged frog in Unit SLO-3 has been excluded from critical habitat designation under section 4(b)(2) of the Act (see Application of Section 4(b)(2) of the Act section below).

SLO-4, Upper Salinas River This unit is comprised of approximately 34,463 ac (13,947 ha) of land, is located at the base of Garcia Mountain about 17 mi (27 km) east of the City of San Luis Obispo, is mapped from occurrences recorded subsequent to the time of listing, and is currently occupied by the species. Based on the life history and population dynamics of the species we have determined that the area was most likely occupied at the time of listing. The unit includes the following watersheds: Horse Mesa, Douglas Canyon, American Canyon, and Coyote Hole. This unit is essential for the conservation of the species because it is the only unit in San Luis Obispo County entirely within the interior Coast Range and provides connectivity between populations in the coastal areas and populations farther inland. SLO-4 also contains permanent and ephemeral aquatic habitats consisting of natural and manmade ponds surrounded by emergent vegetation and marshland with upland dispersal habitat comprised of riparian areas for dispersal, shelter, and foraging. This unit consists of Federal (26,183 ac (10,596 ha)) and private (8,280 ac (3,351 ha)) lands. The physical and biological features essential to the conservation of California red-legged frog in the SLO-4 unit may require special management considerations or protection due to predation by nonnative species, and due to water diversion, overgrazing, and urbanization, which may alter aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or adults due to habitat modification. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

STB-1, La Brea Creek This unit is comprised of approximately 25,164 ac (10,184 ha) of land, is located in Los Padres National Forest in northern Santa Barbara County, and is mapped from occurrences recorded at the time of listing and subsequent to the time of listing. The unit includes the following watersheds: Bear Canyon, the southern portion of Smith Canyon, Rattlesnake Canyon, Lower South Fork La Brea Creek, and the eastern portion of Lower La Brea Creek. STB-1 contains the features that are essential for the conservation of the species. The unit contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). The unit consists of Federal (20,896 ac (8,456 ha)) and private (4,269 ac (1,727 ha)) lands. The physical and biological features essential to the conservation of California red-legged frog in the STB-1 unit may require special management considerations or protection due to recreational activities, which may alter aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or adults. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

STB-2, San Antonio Terrace This unit is comprised of approximately 12,066 ac (4,883 ha) of land, is located in northwestern Santa Barbara County near the coast, extends from about Casmalia south to the Santa Lucia Canyon near the Purisima Hills, and is mapped from occurrences recorded subsequent to the time of listing. Based on the life history and population dynamics of the species we have determined that the area was most likely occupied at the time of listing. The unit includes the following watersheds: Graciosa Canyon and Lions Head. STB-2 provides connectivity between coastal populations and populations in the Transverse Ranges. STB-2 also contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). This unit is currently occupied by the species. The unit consists of Federal (35 ac (14 ha)) and private (12,031 ac (4,869 ha)) lands. A portion of the lands containing features essential to the conservation of the California red-legged frog in Unit STB- 2 has been excluded from critical habitat designation under section 4(b)(2) of the Act (see Application of Section 4(b)(2) of the Act section below). The physical and biological features essential to the conservation of California red-legged frog in the STB-2 unit may require special management considerations or protection due to recreational activities, which may alter aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or adults. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

STB-3, Sisquoc River This unit is comprised of approximately 47,559 ac (19,246 ha) of land and is located in northern Santa Barbara County and includes locations in the Sisquoc River drainage and is mapped from occurrences recorded at the time of listing and subsequent to the time of listing. The unit contains the following watersheds: the southern portion of Tunnel Canyon, Burro Canyon, Sulphur Creek, Lower Manzano Creek, Middle Manzano Creek, Fir Canyon, Upper Cachuma Creek, and the northern portion of Happy Canyon. STB-3 contains the features that are essential for the conservation of the species. The unit contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). STB-3 is occupied by the species, provides connectivity between locations along the coast and the Transverse Ranges, and is essential in stabilizing populations of the species in tributaries to the Santa Ynez River. The unit consists of Federal (40,148 ac (16,247 ha)) and private (7,411 ac (2,999 ha)) land. The physical and biological features essential to the conservation of California red-legged frog in the STB-3 unit may require special management considerations or protection due predation by nonnative species, recreational activities, and poor water management practices which may alter aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or adults. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

STB-4, Jalama Creek This unit is comprised of approximately 7,685 ac (3,110 ha) of land and is located along the coast in southwestern Santa Barbara County about 4.4 mi (7 km) south of the City of Lompoc, and is mapped from occurrences recorded at the time of listing and subsequent to the time of listing. The unit includes the Casper Creek watershed. STB-4 contains the features that are essential for the conservation of the species. The unit includes aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). STB-4 is occupied by the species and provides connectivity between locations along the coast and the Santa Ynez River watershed. This unit consists of Federal (44 ac (18 ha)) and private (7,641 ac (3,092 ha)) lands. The physical and biological features essential to the conservation of California red-legged frog in the STB-4 unit may require special management considerations or protection due to predation by nonnative species and habitat disturbance, which may alter aquatic and upland habitats and thereby result in the direct or indirect loss of egg masses or adults. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations. A portion of the lands containing features essential to the conservation of the California red-legged frog in Unit STB- 4 has been excluded from critical habitat designation under section 4(b)(2) of the Act (see Application of Section 4(b)(2) of the Act section below).

STB-5, Gaviota Creek This unit is comprised of approximately 12,888 ac (5,216 ha) of land, is located along the coast in southern Santa Barbara County about 3 mi (5 km) southwest of the town of Buellton, and is mapped from occurrences recorded at the time of listing and subsequent to the time of listing. The unit includes the following watersheds: Can˜ ada de las Cruces and Can˜ ada de la Gavota. STB-5 contains the features that are essential for the conservation of the species. The unit contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for shelter, foraging and dispersal activities (PCE 3 and PCE 4). STB-5 is occupied by the species and provides connectivity between locations along the coast and the Santa Ynez River watershed. The unit consists of Federal (1,547 ac (626 ha)), State (2,074 ac (839 ha)), and private (9,267 ac (3,750 ha) lands. The physical and biological features essential to the conservation of California red-legged frog in the STB-5 unit may require special management considerations or protection due to predation by nonnative species and poor water management practices, which may alter aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or adults. Populations in this unit may also require special management or protection due to their potential importance in stabilizing California redlegged frog populations in tributaries to the Santa Ynez River. Please see the ‘‘Special Management Considerations or Protection’’ section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

STB-6, Arroyo Quemado to Refugio Creek This unit is comprised of approximately 11,985 ac (4,850 ha) of land, is located along the coast in southern Santa Barbara County about 5 mi (8 km) south of the town of Solvang, and is mapped from occurrences recorded at the time of listing and subsequent to the time of listing. The unit includes the Tajiguas Creek watershed. STB-6 contains the features that are essential for the conservation of the species. The unit contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). STB-6 is occupied by the species, provides connectivity between locations along the coast and the Santa Ynez River watershed, and contains permanent and ephemeral aquatic habitats suitable for breeding, and upland areas for dispersal, shelter, and food. The unit consists of Federal (1,881 ac (761 ha)), State (29 ac (12 ha)), and private (10,075 ac (4,077 ha)) lands. The physical and biological features essential to the conservation of California red-legged frog in the STB-6 unit may require special management considerations or protection due to predation by nonnative species and poor water management practices, which may alter aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or adults. Populations in this unit may also require special management or protection due to their potential importance in stabilizing California redlegged frog populations in tributaries to the Santa Ynez River. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

STB-7, Upper Santa Ynez River and Matilija Creek This unit is comprised of approximately 145,121 ac (58,728 ha) of land, is located in southeastern Santa Barbara County about 5 mi (8 km) north of the City of Santa Barbara, and extends into western Ventura County at Matilija Creek. It is mapped from occurrences recorded at the time of listing and subsequent to the time of listing. The unit includes the following watersheds: Los Lauveles Canyon, Redrock Canyon, Oso Canyon, Buckhorn Creek, Camuesa Creek, Devils Canyon, Indian Creek Campground, Upper Mono Creek, Lower Mono Creek, Blue Canyon Upper Agua Caliente Canyon, Diablo Canyon, Lower Agua Caliente Canyon, Juncal Canyon, Lower Matilija Creek, North Fork Matilija Creek, and Cozy Dell Canyon. STB-7 contains the features that are essential for the conservation of the species. This unit contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). STB-7 is occupied by the species and provides connectivity between locations along the coast, in the Sierra Madre Mountains, and in the Ventura River watershed. It is important to species conservation and the persistence of the species in the Matilija watershed because it contains permanent and ephemeral aquatic habitats suitable for breeding, and upland areas for dispersal, shelter, and food in that portion of the unit, which will provide connectivity between populations within the Transverse Ranges and will prevent further isolation of breeding locations near the limit of the geographic range of the species. The unit as a whole contains high-quality habitat, indicated by the high density of extant occurrences, permanent and ephemeral aquatic habitat suitable for breeding, and accessible upland areas for dispersal, shelter, and food. The unit consists of Federal (124,831 ac (50,517 ha)), State (8 ac (3 ha), and private (20,282 ac (8,208 ha)) lands. The physical and biological features essential to the conservation of California red-legged frog in the STB-7 unit may require special management considerations or protection due to predation by nonnative species, flood control activities, road maintenance, and recreational activities, which may alter aquatic and upland habitats and thereby result in the direct or indirect loss of egg masses or direct death of adults. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

VEN-1, San Antonio Creek This unit is comprised of approximately 2,915 ac (1,180 ha) of land, is located in western Ventura County at San Antonio Creek, and is mapped from occurrences recorded at the time of listing and subsequent to the time of listing, and is currently occupied. The unit includes portions of the following watersheds: a small southern portion of Upper San Antonio Creek, a small western portion of Lion Creek, and the eastern portion of Lower San Antonio Creek. VEN-1 contains the features that are essential for the conservation of the species. The unit contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). Persistence of the species in this area will prevent further isolation of breeding locations near the limit of the geographic range of the species. The unit contains permanent and ephemeral aquatic habitats suitable for breeding and accessible upland areas for dispersal, shelter, and food, and provides connectivity between populations within the Transverse Ranges. The unit consists entirely of private land. The physical and biological features essential to the conservation of California red-legged frog in the VEN-1 unit may require special management considerations or protection due to predation by nonnative species, recreational activities, and sedimentation of aquatic habitats, which may alter aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or adults. Please see the Special Management Considerations or Protection''section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

VEN-2, Piru Creek This unit is comprised of approximately 8,837 ac (3,576 ha) of land, is located in eastern Ventura County and northwestern Los Angeles County, and is mapped from occurrences recorded at the time of listing at Piru Creek. The unit includes the Michael Creek watershed. VEN-2 contains the features that are essential for the conservation of the species. The unit contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for foraging and dispersal activities (PCE 3 and PCE 4). VEN-2 is occupied by the species. Persistence of the species in this area is important to prevent further isolation of breeding locations near the limit of the geographic range of the species, and the unit contains permanent and ephemeral aquatic habitats suitable for breeding, and upland areas for dispersal, shelter, and food. The unit consists of Federal (8,363 ac (3,384 ha)) and private (474 ac (192 ha)) land. The physical and biological features essential to the conservation of California red-legged frog in the VEN-2 unit may require special management considerations or protection due to predation by nonnative species, off-road vehicle use, and conversion of native habitat by introduced invasive plant species, which may alter aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or direct death of adults. Please see the ''Special Management Considerations or Protection'' section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

VEN-3, Upper Las Virgenes Canyon This unit is comprised of approximately 5,000 ac (2,024 ha) of land, is located in southeastern Ventura County, and is mapped from occurrences recorded subsequent to the time of listing. Based on the life history and population dynamics of the species we have determined that the area was most likely occupied at the time of listing. The unit includes the upper portion of Las Virgenes Creek watershed that is north of the Ventura County line. VEN-3 is considered an area that is essential for the conservation of the species because it is currently occupied by the species and provides connectivity between coastal populations and populations in the Transverse Ranges. Further, VEN-3 contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for shelter, foraging, and dispersal activities (PCE 3 and PCE 4). The unit consists of Federal (56 ac (23 ha)) and private (2,896 ac (1,171 ha)) land. Approximately 2,048 ac (830 ha) of land within the unit is managed by the Santa Monica Mountains Conservancy. The physical and biological features essential to the conservation of California red-legged frog in the VEN-3 unit may require special management considerations or protection due to predation by nonnative species, off-road vehicle use, and conversion of native habitat by introduced invasive plant species, which may alter aquatic or upland habitats and thereby result in the direct or indirect loss of egg masses or direct death of adults. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

LOS-1, San Francisquito Creek This unit is comprised of approximately 4,231 ac (1,712 ha) of land, is located in northwestern Los Angeles County, and is mapped from occurrences recorded at the time of listing and is currently occupied. LOS- 1 contains the features that are essential for the conservation of the species. The unit contains aquatic habitat for breeding and non-breeding activities (PCE 1 and PCE 2), and upland habitat for shelter, foraging, and dispersal activities (PCE

3 and PCE 4). The unit consists of Federal (3,909 ac (1,582 ha)) and private land (322 ac (130 ha)) lands. The physical and biological features essential to the conservation of California red-legged frog in the LOS-1 unit may require special management considerations or protection due to predation by nonnative species on egg masses, tadpoles, juveniles, or adults. Please see the Special Management Considerations or Protection section of this final rule for a detailed discussion of the threats to California red-legged frog habitat and potential management considerations.

RIV-1, Cole Creek We have excluded the lands containing features essential to the conservation of the California red-legged frog in Unit RIV-1 from critical habitat designation under section 4(b)(2) of the Act (see Application of Section 4(b)(2) of the Act section below).

Primary Constituent Elements/Physical or Biological Features

Critical habitat units are designated for Alameda, Butte, Calaveras, Contra Costa, El Dorado, Kern, Kings, Los Angeles, Marin, Mendocino, Merced, Monterey, Napa, Nevada, Placer, Riverside, San Benito, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Solano, Sonoma, Stanislaus, Ventura, and Yuba Counties, California. Within these areas, the primary constituent elements for the California red-legged frog consist of four components:

(i) Aquatic Breeding Habitat. Standing bodies of fresh water (with salinities less than 4.5 ppt), including natural and manmade (e.g., stock) ponds, slowmoving streams or pools within streams, and other ephemeral or permanent water bodies that typically become inundated during winter rains and hold water for a minimum of 20 weeks in all but the driest of years.

(ii) Aquatic Non-Breeding Habitat. Freshwater pond and stream habitats, as described in paragraph (2)(i) of this entry, that may not hold water long enough for the species to complete its aquatic life cycle but which provide for shelter, foraging, predator avoidance, and aquatic dispersal of juvenile and adult California red-legged frogs. Other wetland habitats considered to meet these criteria include, but are not limited to: plunge pools within intermittent creeks, seeps, quiet water refugia within streams during high water flows, and springs of sufficient flow to withstand short-term dry periods.

(iii) Upland Habitat. Upland areas adjacent to or surrounding breeding and non-breeding aquatic and riparian habitat up to a distance of 1 mi (1.6 km) in most cases (i.e., depending on surrounding landscape and dispersal barriers) including various vegetational series such as grassland, woodland, forest, wetland, or riparian areas that provide shelter, forage, and predator avoidance for the California red-legged frog. Upland habitat should include structural features such as boulders, rocks and organic debris (e.g., downed trees, logs), small mammal burrows, or moist leaf litter. Upland features are also essential in that they are needed to maintain the hydrologic, geographic, topographic, ecological, and edaphic features that support and surround the aquatic, wetland, or riparian habitat. These upland features contribute to: (A) Filling of aquatic, wetland, or riparian habitats; (B) Maintaining suitable periods of pool inundation for larval frogs and their food sources; and (C) Providing non-breeding, feeding, and sheltering habitat for juvenile and adult frogs (e.g., shelter, shade, moisture, cooler temperatures, a prey base, foraging opportunities, and areas for predator avoidance).

(iv) Dispersal Habitat. Accessible upland or riparian habitat within and between occupied locations within a minimum of 1 mi (1.6 km) of each other and that support movement between such sites. Dispersal habitat includes various natural habitats, and altered habitats such as agricultural fields, that do not contain barriers (e.g., heavily traveled roads without bridges or culverts) to dispersal. Dispersal habitat does not include moderate- to highdensity urban or industrial developments with large expanses of asphalt or concrete, nor does it include large lakes or reservoirs over 50 ac (20 ha) in size, or other areas that do not contain those features identified in paragraphs (2)(i), (2)(ii), and (2)(iii) of this entry as essential to the conservation of the species.

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, aqueducts, airports, and roads, and the land on which such structures are located.

The area designated as revised critical habitat will require some level of management to address current and future threats to the California redlegged frog and maintain the physical and biological features essential to the conservation of the species. Special management will be required in all units to ensure that aquatic and upland habitats provide abundant breeding and non-breeding areas, prey species, shelter, and connectivity within the landscape. The designation of critical habitat does not imply that areas outside of the final revised critical habitat designation do not play an important role in the conservation of the California red-legged frog. Areas outside the final revised critical habitat designation will continue to be subject to conservation actions implemented under section 7(a)(1) of the Act, regulatory protections afforded by the section 7(a)(2) jeopardy standard, and the prohibitions of section 9 of the Act. These protections and conservation tools will continue to contribute to recovery of the species.

Threats that may warrant special management considerations or protection of those features that define essential habitat in the appropriate quantity and spatial arrangement for the California red-legged frog include, but are not limited to: disease; direct and indirect impacts from some human recreational activities; flood control maintenance activities; water diversions; mining; dredging; sedimentation; water chemistry or temperature alterations; pesticide application; overgrazing; competition and predation by nonnative animal species; and habitat removal and alteration by urbanization, timber activities, and nonnative plant introduction. These threats may cause habitat alteration, degradation, or fragmentation and the direct or indirect loss of California red-legged frog eggs, juveniles, or adults or their habitat.

Life History

Food/Nutrient Resources

Food Source

Larvae: Algae, organic debris, plant tissue, and other minute organisms (61 FR 25813; NatureServe 2015).

Adult: The diet of California red-legged frogs is highly variable. Invertebrates tend to be the most common food items of adult frogs. Vertebrates, such as Pacific tree frogs (Hyla regilla) and California mice (Peromyscus californicus), represented more than half of the prey mass eaten by larger frogs. Feeding activity likely occurs along the shoreline and on the surface of the water (61 FR 25813).

Competition

Adult: Nonnative fish; and bullfrogs, which prey on California red-legged frogs, and may have a competitive advantage over California red-legged frogs because of their larger size, generalized food habits, and extended breeding season that allows for production of two clutches of up to 20,000 eggs during a breeding season (USFWS 2002).

Food/Nutrient Narrative

Egg: See Adult life history.

Larvae: See Adult life history.

Adult: California red-legged frogs are generalist, opportunistic herbivores (algae, organic debris, plant tissue, and other minute organisms) as larvae, and invertivores/carnivores as adults. The diet of California red-legged frogs is highly variable. Invertebrates tend to be the most common food items of adult frogs. Vertebrates, such as Pacific tree frogs (Hyla regilla) and California mice (Peromyscus californicus), represented more than half of the prey mass eaten by larger frogs. Feeding activity likely occurs along the shoreline and on the surface of the water (61 FR 25813).Juvenile frogs are known to be active diurnally and nocturnally, whereas adult frogs are largely nocturnal. The species may be inactive in cold temperatures, and in th ehot, dry weather that occurs in late summer to early winter, but may be active all year in coastal areas. Competitors include nonnative fish; and bullfrogs (Lithobates catesbeianus), which prey on California red-legged frogs, and may have a competitive advantage over California red-legged frogs because of their larger size, generalized food habits, and extended breeding season that allows for production of two clutches of up to 20,000 eggs during a breeding season (61 FR 25813; NatureServe 2015; USFWS 2002).

Reproductive Strategy

Adult: Oviparity; substrate spawning.

Lifespan

Adult: Adults may live 8 to 10 years (USFWS 2002).

Breeding Season

Adult: California red-legged frogs are often prolific breeders, laying their eggs during or shortly after large rainfall events in late winter and early spring (61 FR 25813), between November through April (USFWS 2002).

Key Resources Needed for Breeding

Adult: A pair in amplexus (breeding position) moves to an oviposition site (the location where eggs are laid), and the eggs are fertilized while being attached to a brace. Braces include emergent vegetation such as bulrushes (Scirpus spp.) and cattails (Typha spp.) or roots and twigs; the egg masses float on the surface of the water (USFWS 2002).

Other Reproductive Information

Egg: Egg masses that contain about 2,000 to 5,000 moderate-sized (2.0 to 2.8 mm [0.08 to 0.11 in.] in diameter), dark reddish brown eggs (61 FR 25813).

Adult: Males appear at breeding sites from 2 to 4 weeks before females. At these sites, males frequently call in small groups of two to seven individuals, although in some instances they may call individually. Females are attracted to the calling males (USFWS 2002). Egg masses that contain about 2,000 to 5,000 moderate-sized (2.0 to 2.8 mm [0.08 to 0.11 in.] in diameter), dark reddish brown eggs (61 FR 25813). Eggs require approximately 20 to 22 days to develop into tadpoles; however, certain individuals have been shown to overwinter, in which case the metamorphs were observed in March and April from previous breeding seasons (USFWS 2002).

Reproduction Narrative

Egg: See Adult life history.

Larvae: See Adult life history.

Adult: California red-legged frog are oviparous, prolific breeders that lay their eggs during or shortly after large rainfall events in late winter and early spring (61 FR 25813), between November and April (USFWS 2002).Sexual maturity is reached at 2 years of age by males and 3 years of age by females (USFWS 2002). Males appear at breeding sites from 2 to 4 weeks before females. At these sites, males frequently call in small groups of two to seven individuals, although in some instances they may call individually. Females are attracted to the calling males (USFWS 2002).A pair in amplexus (breeding position) moves to an oviposition site (the location where eggs are laid), and the eggs are fertilized while being attached to a brace. Braces include emergent vegetation such as bulrushes (Scirpus spp.) and cattails (Typha spp.) or roots and twigs; the egg masses float on the surface of the water (USFWS 2002). Egg masses that contain about 2,000 to 5,000 moderate-sized (2.0 to 2.8 mm [0.08 to 0.11 in.] in diameter), dark reddish brown eggs (61 FR 25813).Eggs require approximately 20 to 22 days to develop into tadpoles; however, certain individuals have been shown to overwinter, in which case the metamorphs were observed in March and April from previous breeding seasons (USFWS 2002). Of the various life stages, larvae probably experience the highest mortality rates, with fewer than 1 percent of eggs laid reaching metamorphosis; therefore, the reproductive capacity likely ranges between 140 to 350 larvae that reach metamorphosis (USFWS 2002). Adults may live 8 to 10 years (USFWS 2002). California red-legged frogs are “irruptive” breeders where their breeding capacity is highly dependent on local environmental conditions, specifically the availability of cool water for egg deposition and larval maturation (Jennings and Hayes 1994, p. 62). California red-legged frogs breed from November to May and breeding activity typically begins earlier at southern coastal than northern coastal localities (Storer 1925, p. 2; Alvarez et al. 2013, pp. 547–548). Breeding may start as late as March or April in Sierra Nevada localities such as Hughes Pond, due to low temperatures at these sites in January and February (Tatarian and Tatarian 2008, p. 16). Breeding in Southern California localities may start as late as April, as exemplified in Matilija Canyon following the 2017 Thomas Fire (Patrick Lieske, US Forest Service, in litt. 2021). High water flows in the winter and spring also can delay breeding in streams and rivers (East Bay Regional Park District 2017, p. 29). During the breeding season, most non-dispersing frogs remain near the breeding site and do not move far into surrounding terrestrial habitat to forage (Wildlife Research Associates 2008, p. 11; Bulger et al. 2003, pp. 87–88) (USFWS, 2022).

Habitat Type

Egg: Aquatic habitat/breeding sites include pools and backwaters in streams and creeks, ponds, marshes, springs, sag ponds, dune ponds, and lagoons. Additionally, California red-legged frogs frequently breed in artificial impoundments such as stock ponds (USFWS 2002).

Larvae: See Adult life history.

Adult: Occupies a range of habitat types. Breeding habitats: Breeding habitats are fairly distinct, combining both specific water (aquatic) and river bank (riparian) components. Adults need dense, shrubby, or riparian vegetation associated with deep (greater than 0.7 meter (m) [2.5 feet (ft.)], still or slow-moving water. Dispersal and Use of Uplands and Riparian Areas: During periods of wet weather, some individuals make overland excursions through uplands. During dry periods, the species is seldom found far from water, but will sometimes disperse in response to receding water. They spend considerable time resting and feeding in riparian areas. Summer habitat: If water is not available, they will forage and seek summer habitat. Summer habitat includes small mammal burrows, organic debris (moist leaf litter), incised stream channels, spaces under boulders or rocks, and agricultural features (USFWS 2002).

Habitat Vegetation or Surface Water Classification

Egg: Riverine (creeks, low-gradient pools) and lacustrine (shallow water) (NatureServe 2015).

Larvae: See Adult life history.

Adult: Riverine (creeks, low-gradient pools) and lacustrine (shallow water) (NatureServe 2015). Riparian areas are important for dispersal and summer habitat. Uplands including annual grasslands and oak woodlands are important for dispersal. California red-legged frog aquatic habitat/breeding sites include pools and backwaters in streams and creeks, ponds, marshes, springs, sag ponds, dune ponds, and lagoons. Additionally, California red-legged frogs frequently breed in artificial impoundments such as stock ponds (USFWS 2002).

Dependencies on Specific Environmental Elements

Egg: Eggs are deposited attached to vertical emergent vegetation, such as bulrushes (Scirpus spp.) or cattails (Typha spp.) (61 FR 25813).

Larvae: See Adult life history.

Adult: Breeding ponds, upland refugia, and nonbreeding aquatic habitat.

Geographic or Habitat Restraints or Barriers

Larvae: See Adult life history.

Adult: Roads, water diversion, water projects, dams, land conversion, habitat loss/fragmentation, wide or fast-flowing rivers and streams, lakes greater than 20 ha (50 ac.), and – environmentally – temporary and permanent habitat loss as a result of drought/flooding (61 FR 25813; 75 FR 12816).

Spatial Arrangements of the Population

Larvae: See Adult life history.

Adult: Clumped

Environmental Specificity

Larvae: See Adult life history.

Adult: Narrow. Specialist or community with key requirements common.

Tolerance Ranges/Thresholds

Egg: See Adult life history.

Larvae: See Adult life history.

Adult: Moderate. Species adapts to changes in temporal and spatial changes in habitat quality.

Site Fidelity

Egg: See Adult life history.

Larvae: See Adult life history.

Adult: Moderate

Dependency on Other Individuals or Species for Habitat

Egg: See Adult life history.

Larvae: See Adult life history.

Habitat Narrative

Egg: See Adult life history.

Larvae: See Adult life history.

Adult: The California red-legged frog occupies a variety of habitat throughout a given year that can be categorized as breeding, uplands and riparian habitat, and summer habitat. Breeding habitats are fairly distinct, combining both specific water (aquatic) and river bank (riparian) components. Adults need dense, shrubby, or riparian vegetation associated with deep (greater than 0.7 m [2.5 ft.]), still or slow-moving water. During periods of wet weather, some individuals make overland excursions through uplands. During dry periods, the species is seldom found far from water, but will sometimes disperse in response to receding water. They spend considerable time resting and feeding in riparian areas. In the summer, if water is not available, they will forage and seek summer habitat. Summer habitat includes small mammal burrows, organic debris (moist leaf litter), incised stream channels, spaces under boulders or rocks, and agricultural features (USFWS 2002).They typically inhabit riverine (creeks, low-gradient pools), lacustrine (shallow water), and palustrine (herbaceous wetland, riparian) habitats. In upland areas, they may range far from water along riparian corridors and in damp thickets and forests, where they may burrow in or use soil or fallen logs/debris as cover (NatureServe 2015). California red-legged frog aquatic habitat/breeding sites include pools and backwaters in streams and creeks, ponds, marshes, springs, sag ponds, dune ponds, and lagoons. Additionally, California red-legged frogs frequently breed in artificial impoundments such as stock ponds (USFWS 2002).Despite the California red-legged frog's ability to use multiple habitat types, there are certain habitat features they require. Most important is a breeding pond, or slow-flowing stream reach or deep pool in a stream with vegetation or other material to which egg masses may be attached. These areas must hold water long enough for tadpoles to complete their metamorphosis into juvenile frogs that can survive outside of water. Juveniles have been observed inhabiting a wide variety of habitats, while adults primarily inhabit deep pools. In northern California, many California red-legged frog populations occupy artificially created wetland environments. Historically, as natural wetlands and streams were converted for agriculture, flood control, and urban development, the California red-legged frog colonized small artificial impoundments, or stock ponds, created by cattle ranchers for the purpose of providing water for their cattle. Without these stock ponds, the range of the California red-legged frog would be more limited in this region (75 FR 12816).Riparian and upland habitats adjacent to aquatic areas used by the California red-legged frog are essential in maintaining frog populations, and for protecting the appropriate hydrological, physical, and water quality conditions of the aquatic areas. Riparian habitat includes vegetation that grows along banks, in the floodplains of streams, and adjacent to ponds; and that is dependent on the bordering water source for survival. Adjacent uplands are marked by vegetation that is not dependent on a nearby supply of surface water. The California red-legged frog uses both riparian and upland habitats for foraging, shelter, cover, and nondispersal movement (75 FR 12816).California red-legged frogs will disperse from their breeding habitat to forage and seek suitable upland and riparian habitat if aquatic habitat is not available at distances of between 26 and 92 m (85 and 302 ft.) from aquatic habitat for up to 65 days. These upland habitat areas used by the California red-legged frog include structures that provide shade, moisture, and cooler temperatures. These structures may be natural, such as the spaces under boulders or rocks and organic debris (e.g., downed trees or logs), or man-made, such as certain industrial debris and agricultural features (e.g., drains, watering troughs, abandoned sheds, or stacks of hay or other vegetation). The California red-legged frog will also use small mammal burrows and moist leaf litter as refugia (areas whose climate remains habitable when that of the surrounding areas has changed) (75 FR 12816).California red-legged frogs live in a Mediterranean climate, which brings about temporal and spatial changes in habitat quality. Almost the entire landscape, not just breeding ponds and streams, may become suitable habitat for the adults during periods of above-average rainfall. Conversely, habitat that is suitable may be drastically reduced during periods of prolonged drought. Habitats used by the California red-legged frog typically change in extent and suitability in response to the dynamic nature of floodplain and fluvial processes (i.e., variable natural water flow and sedimentation regimes that create, modify, and eliminate deep pools, backwater areas, ponds, marshes, and other aquatic habitats). Range-wide, and even within local populations, the California red-legged frog uses a variety of areas, including aquatic, riparian, and upland habitats. They may complete their entire life cycle in a particular habitat (e.g., a pond is suitable for all life stages), or they may seek multiple habitat types depending on climatic conditions or distance between and availability of wetland and other suitably moist environments. Due to this variability, population sizes can vary widely from year to year. During years when aquatic habitat (ponds and streams) is abundant as a result of adequate rainfall, the California red-legged frog can produce large numbers of dispersing young, resulting in an increase in the number of occupied sites. In contrast, the California red-legged frog may temporarily disappear from an area during periods of extended drought (75 FR 12816).Geographic and physical barriers include roads, water diversion, water projects, dams, land conversion, habitat loss/fragmentation, wide or fast-flowing rivers and streams, lakes greater than 20 ha (50 ac.), and – environmentally – temporary and permanent habitat loss as a result of drought/flooding (61 FR 25813).

Dispersal/Migration

Motility/Mobility

Larvae: Low

Adult: Moderate

Dispersal

Adult: May disperse from breeding sites at any time of year, depending on habitat availability and the environmental conditions of the aquatic habitat (75 FR 12816).

Dispersal/Migration Narrative

Egg: See Adult life history.

Larvae: See Adult life history.

Adult: Adult California red-legged frogs are nonmigratory, but capable of moderate dispersal events. Dispersal distances are considered to be dependent on habitat availability and the environmental conditions of the aquatic habitat.During periods of wet weather, starting with the first rains of fall, some individuals may make overland excursions through upland habitats. Most of these overland movements occur at night. Evidence from marked and radio-tagged frogs on the San Luis Obispo County coast suggests that frog movements, via upland habitats, of about 1.6 km (1 mi.) are possible over the course of a wet season. Frogs have been observed to make long-distance movements that are straight-line, point-to-point migrations, rather than using corridors for moving between habitats. Dispersing frogs in northern Santa Cruz County traveled distances from 0.40 km (0.25 mi.) to more than 3 km (2 mi.) without apparent regard to topography, vegetation type, or riparian corridors (USFWS 2002). During dry periods, the California red-legged frog is rarely encountered far from water. However, California red-legged frogs will sometimes disperse in response to receding water, which often occurs during the driest time of the year (USFWS 2002).The movement (i.e., dispersal) of frogs between areas containing suitable upland and aquatic habitats can be restricted due to inhospitable conditions around and between areas of suitable habitats (75 FR 12816). Most California red-legged frogs appear to move away from breeding sites, but only a few disperse farther than the nearest nonbreeding habitat, and the distance moved is highly dependent on site conditions and local landscapes (75 FR 12816).

Additional Life History Information

Adult: The movement (i.e., dispersal) of frogs between areas containing suitable upland and aquatic habitats can be restricted due to inhospitable conditions around and between areas of suitable habitats (75 FR 12816).

Population Information and Trends

Population Trends:

Long-term trend: Decline of 50 to 70 percent. Over the long term, the extent of occurrence, area of occupancy, number of subpopulations, and population size have undergone a major decline. The species has been extirpated from much of its former range in California, and its range has been reduced by 70 percent (NatureServe 2015).

Species Trends:

Short-term trend: Decline of 10 to 30 percent. Currently, area of occupancy, number of subpopulations, and population size probably are still declining, but the rate of decline is unknown (NatureServe 2015).

Number of Populations:

The number of distinct occurrences (subpopulations) is unknown, but probably is at least several dozen. As of 2000, the species occurs in about 238 streams or drainages (NatureServe 2015).

Population Size:

10,000 to 100,000 individuals (NatureServe 2015).

Adaptability:

Low

Additional Population-level Information:

The total adult population size is unknown, but undoubtedly exceeds 10,000. The species is still locally abundant in portions of the San Francisco Bay Area and the central coast. Breeding sites in Marin County include several thousand adults (NatureServe 2015).In the mid-1990s, most of the occupied habitat was in Monterey, San Luis Obispo, and Santa Barbara counties; the species occurred in only five sites south of the Tehachapi Mountains (80+ historic sites). Aggregations including more than 350 adults were known only from Pescadero Marsh Natural Preserve in coastal San Mateo County, Point Reyes National Seashore in Marin County, and Rancho San Carlos in Monterey County. More than 120 breeding sites exist in Marin County (NatureServe 2015).In California, south of Los Angeles, a single population is known from the Santa Rosa Plateau in Riverside County. Only two populations are known to exist south of Santa Barbara (NatureServe 2015).In the Sierra Nevada, the species is now represented by only about a half dozen populations, only one of which is known to have more than 10 breeding adults (NatureServe 2015).Currently, the area of occupancy, number of subpopulations, and population size probably are still declining, but the rate of decline is unknown (NatureServe 2015).

Population Narrative:

The total adult population size of California red-legged frog is unknown, but undoubtedly exceeds 10,000. The species is still locally abundant in portions of the San Francisco Bay Area and the central coast. Breeding sites in Marin County include several thousand adults. Currently, the species' area of occupancy, number of subpopulations, and population size probably are still declining, but the rate of decline is unknown. Over the long term, the extent of occurrence, area of occupancy, number of subpopulations, and population size have undergone a major decline. The species has been extirpated from much of its former range in California, and its range has been reduced by 70 percent (NatureServe 2015).In the mid-1990s, most of the occupied habitat was in Monterey, San Luis Obispo, and Santa Barbara counties; the species occurred in only five sites south of the Tehachapi Mountains (80+ historic sites). Aggregations including more than 350 adults were known only from Pescadero Marsh Natural Preserve in coastal San Mateo County, Point Reyes National Seashore in Marin County, and Rancho San Carlos in Monterey County. More than 120 breeding sites exist in Marin County. In California, south of Los Angeles, a single population is known from the Santa Rosa Plateau in Riverside County. Only two populations are known to exist south of Santa Barbara. In the Sierra Nevada, the species is now represented by only about a half dozen populations, only one of which is known to have more than 10 breeding adults (NatureServe 2015).The number of distinct occurrences (subpopulations) is unknown, but probably is at least several dozen. As of 2000, the species occurs in about 238 streams or drainages. The total population size is estimated at 10,000 to 100,000 individuals (NatureServe 2015).

Threats and Stressors

Stressor: Habitat loss and alteration
Exposure: Indirect
Response: Habitat degradation/loss.
Consequence: Mortality, extirpation, and habitat degradation and loss.
Narrative: Habitat loss and alteration are the primary factors that have negatively affected the California red-legged frog throughout its range. For example, in the Central Valley of California, more than 90 percent of historic wetlands have been diked, drained, or filled, primarily for agricultural development and secondarily for urban development. Wetland alterations, clearing of vegetation, and water diversions that often accompany agricultural development make aquatic sites unsuitable for California red-legged frogs. Urbanization with its associated roadway, stream channelization, and large reservoir construction projects has significantly altered or eliminated California red-legged frog habitat, with the greatest impact occurring in southern California. The majority of extant localities are isolated and fragmented remnants of larger historical populations (61 FR 25813).

Stressor: Habitat degradation
Exposure: Indirect
Response: Habitat degradation and loss.
Consequence: Mortality, extirpation, habitat degradation and loss, and exotic predator invasion.
Narrative: Loss of habitat and decreases in habitat quality will occur as a result of onsite degradation of the stream environment and/or riparian corridor, or through modification of instream flow. Where streams or wetlands occur in urban areas, the quality of California red-legged frog habitat is degraded by a variety of factors. Among these factors are introduction of exotic predators, elimination of streambank vegetation, collecting, and loss of upland habitat (61 FR 25813).

Stressor: Water projects
Exposure: Indirect
Response: Habitat degradation and loss.
Consequence: Mortality, extirpation, habitat degradation and loss, and exotic predator invasion.
Narrative: Water projects, which accompany urban and agricultural growth, have had a negative effect on California red-legged frogs and their habitat. The construction of large reservoirs, such as Lake Oroville, Whiskeytown Reservoir, Don Pedro Reservoir, Lake Berryessa, San Luis Reservoir, Lake Silverwood, Lake Piru, Pyramid Lake, and Lower Otay Lake, have eliminated California red-legged frog habitat or fragmented remaining aggregations (61 FR 25813). The timing and duration of water releases from reservoirs, particularly on the central California coast, can render a stream unsuitable for California red-legged frog reproduction and maintain populations of exotic predators in downstream areas that would normally be dry in summer. Reservoirs are typically stocked with predatory species of fish and bullfrogs. These species often disperse into surrounding California red-legged frog habitat, disrupting natural community

dynamics. California red-legged frogs generally were extirpated from downstream portions of a drainage 1 to 5 years after filling of a reservoir. In some larger drainages, however, isolated California red-legged frog populations have persisted upstream (61 FR 25813).

Stressor: Water diversion
Exposure: Indirect
Response: Habitat degradation and loss, and increased predators.
Consequence: Mortality, extirpation, habitat degradation and loss, altered water regimes, and exotic predator invasion.
Narrative: Water diversions, groundwater well development, and stock pond or small reservoir construction projects degrade or eliminate habitat. Diverting water from natural habitats to these projects disrupts the natural hydrologic regime. During periods of drought, reduced availability of water in natural drainages—combined with drawdown from the impoundments—disrupts reproduction, foraging, estivation, and dispersal. Most waterways on the southern coast of Santa Barbara County are diverted to agriculture and other uses, leaving some completely desiccated. Stock ponds and small reservoirs also support populations of exotic fishes and bullfrogs. The potential adverse effects of water projects to California red-legged frogs include (1) altered water regimes in existing and any proposed delivery facilities of individual water districts; (2) spills, leaks, malfunctions, and operational errors that lead to introduction of exotic predators into isolated stream segments currently occupied by California red-legged frogs; and (3) indirect effects associated with expanded urbanization (61 FR 25813).

Stressor: Storm damage repair and flood-control maintenance
Exposure: Indirect
Response: Habitat degradation and loss.
Consequence: Habitat degradation and loss.
Narrative: Storm damage repair and flood-control maintenance on streams are current threats to California red-legged frogs. Routine flood-control maintenance includes vegetation removal, herbicide spraying, shaping of banks to control erosion, and desilting of the creek, all of which degrade California red-legged frog habitat (61 FR 25813).

Stressor: Road maintenance
Exposure: Indirect
Response: Habitat degradation and loss, and mortality.
Consequence: Habitat degradation and loss, and mortality.
Narrative: Routine road maintenance, trail development, and facilities construction activities associated with parks in or adjacent to California red-legged frog habitat can result in increased siltation in the stream. If this siltation occurs during the breeding season, asphyxiation of eggs and small California red-legged frog larvae can result (61 FR 25813).

Stressor: Placer mining
Exposure: Indirect
Response: Habitat degradation and loss, and mortality.
Consequence: Habitat degradation and loss, and mortality.
Narrative: Placer mining may threaten California red-legged frog habitat through the introduction of heavy siltation in late spring and summer, resulting from upstream gold mining. Deep holes in streams created by instream placer mining also may provide habitat for exotic predatory fish (61 FR 25813).

Stressor: Road-kill
Exposure: Direct
Response: Mortality
Consequence: Mortality and extirpation.
Narrative: Road-killed California red-legged frogs have been documented at several locations in San Mateo and Santa Cruz counties. Road kills may deplete frog aggregations in borderline habitat and otherwise protected areas. Where roads cross or lie adjacent to California red-legged frog habitat, they may act as barriers to seasonal movement and dispersal (61 FR 25813).

Stressor: Livestock grazing
Exposure: Indirect/direct.
Response: Habitat degradation and loss, and mortality.
Consequence: Mortality, extirpation, and habitat degradation and loss.
Narrative: Livestock grazing is another form of habitat alteration that is contributing to declines in the California red-legged frog. Numerous studies have shown that livestock grazing negatively affects riparian habitat. Cattle have an adverse effect on riparian and other wetland habitats, because they tend to concentrate in these areas, particularly during the dry season. Cattle trample and eat emergent and riparian vegetation, often eliminating or severely reducing plant cover. Loss of riparian vegetation results in increased water temperatures, which encourages bullfrog reproduction. Riparian vegetation loss due to cattle grazing includes the loss of willows, which are associated with the highest densities of California red-legged frogs. Cattle grazing also results in increased erosion in the watershed, which accelerates the sedimentation of deep pools used by California red-legged frogs, and adversely affects aquatic invertebrates. Aquatic invertebrates are common prey items of California red-legged frogs (61 FR 25813). Detrimental effects of livestock grazing include nutrient loading, reduction of shade and cover with resultant increases in water temperature, increased intermittent flows, changes in stream channel morphology, and the addition of sediment due to bank degradation and offsite soil erosion. Indirect effects of increased water temperatures can be lethal to aquatic species and include creating a more favorable environment for introduced species, changing the food chain, degrading water quality through decreased dissolved oxygen, increased production of algae, and increased pH and ammonia (61 FR 25813). Grazing effects are not limited to riparian areas. Improper grazing of upland vegetation can expose soils to erosive impacts of raindrops, reduce water infiltration, and accelerate runoff. This can erode topsoil and cut rills and gullies, concentrating runoff, deepening gullies, lowering water tables, and increasing sediment production. Sediment introduced into streams can alter primary productivity and food supply, and fill interstitial spaces in streambed material, impeding water flow, reducing dissolved oxygen levels, and restricting waste removal. Suspended sediments reduce light penetration to plants and reduce the oxygen carrying capacity of the water. Reduction in photosynthesis and primary production decreases productivity of the entire ecosystem (61 FR 25813). Livestock grazing can cause a nutrient-loading problem (due to urination and defecation) in areas where cattle are concentrated near the water, but in other areas it can reduce nutrients through removal of riparian vegetation (61 FR 25813).

Stressor: Feral pigs
Exposure: Indirect
Response: Habitat degradation and loss.
Consequence: Habitat degradation and loss.

Narrative: In addition to cattle, feral pigs (Sus scrofa) also disturb the riparian zone through their rooting, wallowing, and foraging behavior in the shallow margins of water bodies. Feral pigs disturb and destroy vegetative cover, trample plants and seedlings, and cause erosion (61 FR 25813).

Stressor: Off-road vehicles
Exposure: Indirect/direct.
Response: Habitat degradation and loss, and mortality.
Consequence: Habitat degradation and loss, and mortality.
Narrative: Off-road vehicle use adversely affects California red-legged frogs in ways similar to livestock grazing and feral pig disturbance. Off-road vehicles damage riparian vegetation; increase siltation in pools; disturb the water in stream channels; and crush eggs, larvae, juveniles, and adults (61 FR 25813).

Stressor: Heavy recreation
Exposure: Indirect
Response: Habitat degradation and loss.
Consequence: Habitat degradation and loss.
Narrative: Heavy recreational use of parks (e.g., fishing, hiking, and exploring) also can degrade habitat for the California red-legged frog (61 FR 25813).

Stressor: Timber harvest
Exposure: Indirect/direct.
Response: Habitat degradation and loss, and mortality.
Consequence: Habitat degradation and loss, and mortality.
Narrative: Timber harvest threatens California red-legged frogs through loss of riparian vegetation and increased erosion in the watershed, which fills pools with sediment and smothers egg masses (61 FR 25813).

Stressor: Disease
Exposure: Indirect/direct.
Response: Mortality and reduced fitness.
Consequence: Mortality, extirpation, reduction in population numbers, and habitat degradation and loss.
Narrative: Pathogens and parasites have been implicated in the decline of other frog species, but there has not been an extensive examination of how disease may adversely affect California red-legged frog populations. It has been suggested that increased levels of UV-B radiation or air pollutants cause a weakening of the immune system, which could increase the susceptibility of frogs to natural diseases. Another hypothesis, supported by observations, is that disease carried by planted trout may attack and kill amphibian eggs and larvae. The yeast Candida humicola, which is a naturally occurring pathogen, has been documented on northern red-legged frogs. Infected frogs were more susceptible to predation due to changes in their ability to detect predators and changes in their thermoregulatory behavior. Little information exists concerning the distribution of this pathogen. A high incidence of parasites has been observed in bullfrogs that coexist with California red-legged frogs (>90 percent of sampled population with evidence of infection) in southern California. Data have not yet been collected to determine whether California red-legged frogs are also contaminated in these areas; however, adult red-legged frogs appear to be in poor condition, with low body weight. Chytrid fungus has been found in a

number of amphibian populations that are known to be declining. Although it is not yet clear what role the fungus plays in the decline of California red-legged frogs, it is appropriate to take some precautions against spreading fungus between sites. The disease is now being studied in detail to understand its origin, incidence, distribution, and control methods (USFWS 2002).

Stressor: Predation
Exposure: Direct
Response: Higher susceptibility to mortality and extirpation.
Consequence: Mortality and extirpation, and reduction in population numbers.
Narrative: Introduced predators of particular concern are the bullfrog, red swamp crayfish (Procambarus clarkii), signal crayfish (Pacifastacus leniusculus), and several species of fish, including bass, catfish (Ictalurus spp.), sunfish, and mosquitofish. All species were introduced into California in the late 1800s and early 1900s, and through range expansions, reintroductions, and transplants have become established throughout most of the state (61 FR 25813). Introduced bullfrogs, crayfish, and species of fish have been a significant factor in the decline of the California red-legged frog. Several researchers in central California have noted the decline and eventual disappearance of California red-legged frogs once bullfrogs become established at the same site. Changes in habitat that are unfavorable to California red-legged frogs tend to be favorable to a suite of introduced nonnative aquatic predators, making it difficult to identify detrimental effects of specific introduced species on California red-legged frogs. Overall, although California red-legged frogs are occasionally known to persist in the presence of either bullfrogs or mosquitofish (and other nonnative species), the combined effects of both nonnative frogs and nonnative fish often leads to extirpation of red-legged frogs (USFWS 2002).

Stressor: Introduced fish
Exposure: Indirect/direct.
Response: Higher susceptibility to mortality and extirpation, increased competition, and habitat degradation.
Consequence: Mortality and extirpation, reduction in population numbers, habitat degradation and loss, and decreased reproductive success.
Narrative: A negative correlation between the abundance of introduced fish species and California red-legged frogs has been documented whereby aquatic sites where introduced fishes were abundant rarely had native ranids; and when present, ranid populations were small. Recent studies show that mosquitofish and bluegill (Lepomis macrochirus) are significant predators of California red-legged frog larvae. However, California red-legged frogs have been found in association with mosquitofish. Mosquitofish also may compete with California red-legged frogs by consuming aquatic insects that are potential food sources for post-metamorphic frogs. Mosquitofish have become established statewide and are stocked routinely by mosquito abatement districts as a mosquito control measure (61 FR 25813).

Stressor: Inadequacy of existing regulatory mechanisms
Exposure: Indirect
Response:
Consequence: Species and habitat lack sufficient protection.
Narrative: Although the California red-legged frog is classified as a species of special concern by the State of California and may not be taken without an approved scientific collecting permit, this designation provides no special, legally mandated protection of the species and its habitat. The Endangered Species Act is the primary federal law that provides protection for the California red-

legged frog since its listing as a threatened species in 1996. There is typically a net loss of California red-legged frog individuals and habitat with each authorized project (USFWS 2002). Section 404 of the Clean Water Act is another federal law that potentially provides some protection for aquatic habitats of the California red-legged frog, if the habitats are determined to be jurisdictional areas (i.e., waters of the United States) by the U.S. Army Corps of Engineers. Upland habitats adjacent to riparian zones and other wetlands are not provided any protection by Section 404 of the Clean Water Act. Upland areas provide important dispersal, estivation, and summer habitat for this species (USFWS 2002).

Stressor: Drought
Exposure: Indirect/direct.
Response: Higher susceptibility to mortality and extirpation, and habitat degradation.
Consequence: Mortality and extirpation, reduction in population numbers, habitat degradation/loss, decreased reproductive success, and reduction of predator population.
Narrative: Long-term survival of California red-legged frogs may be compromised by the elimination of refuge areas during times of the year when the stream is dry. However, California red-legged frog populations are undoubtedly capable of recovering from drought, provided other factors have not irreparably degraded their habitat, or California red-legged frogs have not been completely extirpated from the drainage. Drought also may play a role in decreased California red-legged frog reproduction where frogs occur in coastal lagoons. High salinities have been attributed to drought conditions in certain watersheds (61 FR 25813). Decreased surface flows in some coastal streams (e.g., Pescadero Creek [San Mateo County], San Simeon Creek [San Luis Obispo County]) during drought years, coupled with agricultural, industrial, and residential groundwater demands, can result in desiccation or increased salinity of water sufficient to kill most if not all of a year’s reproduction. Drought conditions have the potential to eliminate a high proportion of the reproductive effort of California red-legged frogs in the coastal region where the largest populations of the species remain. On the other hand, because California red-legged frogs metamorphose in 1 year and bullfrog larvae require at least 2 years, occasional droughts can benefit California red-legged frogs by reducing the numbers of exotic fish and bullfrogs.

Stressor: Wildfire
Exposure: Indirect/direct.
Response: Habitat degradation and loss, and mortality.
Consequence: Mortality, extirpation, reduction in population numbers, and habitat degradation and loss.
Narrative: Periodic wildfires may adversely affect California red-legged frogs by causing direct mortality, destroying streamside vegetation, or eliminating vegetation that protects the watershed. Following a fire, extensive erosion in a watershed could also negatively affected California red-legged frogs and their habitat (61 FR 25813).

Stressor: Flooding
Exposure: Indirect
Response: Habitat degradation and loss.
Consequence: Habitat degradation and loss.
Narrative: Extensive flooding has been cited as a significant contributing factor in the extirpation of the California red-legged frog from desert drainages of southern California. Extensive flooding in other portions of the California red-legged frog range may have combined with other factors to eliminate California red-legged frog aggregations (61 FR 25813).

Stressor: Habitat fragmentation
Exposure: Indirect/direct.
Response: Habitat degradation, loss, and fragmentation.
Consequence: Habitat degradation, loss, and fragmentation.
Narrative: A considerable amount of occupied California red-legged habitat exists in the form of isolated patches along stream courses. These patches of suitable habitat represent mere remnants of a much larger historical habitat that once covered whole drainages. Fragments of formerly extensive populations of California red-legged frogs are now isolated from other populations. Populations isolated in habitat fragments are vulnerable to extinction through random environmental events or anthropogenic catastrophes. Once a local extinction event occurs in an isolated habitat fragment, the opportunity for recolonization from a source population is reduced. Thus, local extinctions via stochastic processes, coupled with habitat fragmentation, may represent a substantial threat to the continued existence of the California red-legged frog over much of its range (61 FR 25813).

Stressor: Contaminants
Exposure: Indirect/direct.
Response: Higher susceptibility to mortality and extirpation.
Consequence: Mortality and extirpation, reduction in population numbers, decreased fitness, and decreased reproductive success.
Narrative: The California red-legged frog continues to be exposed to a variety of toxins throughout its range. The sensitivity of this species to pesticides, heavy metals, air pollutants, and other contaminants is largely unknown. Studies using other species of amphibians, however, provide toxicity data that are relevant to the potential vulnerability of the California red-legged frog. Ranid tadpoles are likely to be killed or paralyzed by some herbicides (e.g., triclopyr) and insecticides (e.g., fenitrothion). Some pesticides mimic estrogen in vertebrates, and this has been proposed as a hypothesis for amphibian declines (USFWS 2002).

Stressor: Agriculture (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: As in the Service’s 2002 Recovery Plan, we distinguish monotypic agricultural activities (e.g., viticulture, row farming, or timber harvest) from ranching and grazing activities. Similar to urbanization, agriculture creates isolated habitat fragments and barriers to dispersal for California red-legged frog. Agriculture can reduce water available to the species in the area, introduce contaminants such as pesticides and sediment into suitable habitat, and facilitate the presence of predators such as raccoons and bullfrogs. Illegal, unpermitted cannabis cultivation sites in particular are known to degrade habitat by converting habitat on protected lands and drafting water from neighboring aquatic habitat. Notably, the habitat fragmentation produced by agriculture is of a lesser magnitude than the fragmentation produced by urbanization because agricultural lands generally remain permeable for dispersing California red-legged frogs and individuals can use water impoundments on agricultural lands such as frost ponds for shelter during movements (USFWS, 2022).

Stressor: Pesticides (USFWS, 2022)
Exposure:

Response:
Consequence:
Narrative: The Service's 2002 Recovery Plan for the species described pesticide use as a potential significant threat to the species and attributed in part the species' decline in the Central Valley to heavy use of pesticides in the area (Service 2002, pp. 28 –30). Biologists have continued to observe persistence and breeding of California red-legged frog populations in areas of heavy agricultural pesticide use such as near Santa Maria in Santa Barbara County and Watsonville in Santa Cruz County (CNDDB 2022). Laboratory experiments have observed strong negative effects on amphibians from exposure to glyphosate-based herbicides, a specific class of pesticides with polyethoxylated tallowamine surfactant (e.g., Roundup herbicide; Govindarajulu 2008, pp. 3–8). Nevertheless, California red-legged frogs persist in areas of heavy herbicide use such as recreational parks and golf courses and it appears that nearby pesticide use, including herbicides, do not preclude the presence of California red-legged frogs. However, pesticides may still degrade habitat quality in general by causing algal blooms, reducing the prey base for the species in an area, altering the natural composition of vegetation, or decreasing the cover available to California red-legged frogs. Consequently, the U.S. Environmental Protection Agency has issued regulations prohibiting the application of certain pesticides in and around California red-legged frog habitat (https://www.epa.gov/endangered-species/how-complyrequirements-protect-california-red-legged-frog-pesticides). Accordingly, pesticide use remains a potential threat to the California red-legged frog (USFWS, 2022).

Recovery

Reclassification Criteria:
Reclassification or uplisting criteria have not been established for this species.

Recovery Priority Number: 5C

Delisting Criteria:
Eight recovery units have been established for the California red-legged frog. Because of the varied status of this subspecies and differing levels of threats throughout its range, recovery strategies differ per recovery unit to best meet the goal of delisting the species. Delisting of this species will be considered when:

Suitable habitats in all core areas (described below) are protected and/or managed for the California red-legged frog in perpetuity, and the ecological integrity (e.g., water quality, uplands condition, and hydrology) of these areas is not threatened by adverse anthropogenic habitat modification (including indirect effects of upstream/downstream land uses) (USFWS 2002).

Existing populations, throughout the range, are stable (i.e., reproductive rates allow for long-term viability without human intervention). Because population numbers do not necessarily indicate stability (i.e., a population may have large numbers of individuals one year and then decline precipitously, as documented at the Santa Rosa Plateau locality), long-term evidence of successful reproduction (e.g., presence of juveniles) and survivorship into different age classes provides a better indication of stability, persistence, and population resilience. Therefore, population status will be documented through establishment and implementation of a scientifically acceptable population monitoring program for at least a 15-year period (four to five generations) that includes an average precipitation cycle (a period when annual rainfall includes average to 35 percent above-average through greater than 35 percent below-average and back to average or greater; the direction of change is unimportant in this criterion) (USFWS 2002).

Populations are geographically distributed in a manner that allows for the continued existence of viable metapopulations despite fluctuations in the status of individual subpopulations (i.e., when populations are stable at each core area) (USFWS 2002).

The species is successfully reestablished in portions of its historic range in such a way that at least one reestablished population is stable/increasing in each core area where frogs are currently absent (USFWS 2002).

The amount of additional habitat needed for population connectivity, recolonization, and dispersal has been determined, protected, and managed for the California red-legged frog. There will be varying scales of connectivity needed, including at the level of a local population (i.e., connectivity of habitat in a drainage) up to the needs of a metapopulation (many linked drainages over large regions such as recovery units). This will provide dispersal opportunities for population viability, genetic exchange, and recolonization (USFWS 2002).

Recovery Actions:

- Develop and implement watershed management and protection plans for core areas (USFWS 2002).
- Develop and implement watershed management and protection plans for each watershed that currently supports populations of the California red-legged frog (priority 2 watersheds) (USFWS 2002).
- Develop and implement watershed management and protection plans for each watershed that was historically occupied by the California red-legged frog (priority 3 watersheds) (USFWS 2002).
- Develop and implement conservation plans (e.g., Habitat Conservation Plans) for the California red-legged frog on all state and regional parks and water/utility district lands within the historic and current range (USFWS 2002).
- Work with county planners and local water districts to minimize the effects of urban and suburban development and associated activities by developing regional plans and/or habitat conservation plans (USFWS 2002).
- Implement regional ecosystem strategies via existing regulatory processes to minimize the effects of incidental take resulting from land uses and development activities, and optimize benefits to the California red-legged frog derived from mitigation and compensation actions (USFWS 2002).
- Develop and implement guidelines for improving water quality within the range of the California red-legged frog (USFWS 2002).
- Implement air quality standards where poor quality is contributing to degraded conditions for the California red-legged frog (USFWS 2002).
- Prevent the spread of disease and parasites in the California red-legged frog (USFWS 2002).
- Restore habitat conditions for the California red-legged frog at or near historical localities, and where feasible, reestablish populations at extirpated localities (i.e. unoccupied core areas) (USFWS 2002).

- Conduct research on the biology of the California red-legged frog and its habitat requirements (USFWS 2002).
- Increase public awareness and involvement in the protection of the California red-legged frog and native, co-occurring species (USFWS 2002).
- Assess effects of various conservation efforts on co-occurring, native species (USFWS 2002).
- In 2005 the U.S. Fish and Wildlife Service prepared a Revised Guidance on Site Assessment and Field Surveys for the California Red-Legged Frog (Guidance). Two procedures are recommended in the Guidance to accurately assess the likelihood of California red-legged frog presence in the vicinity of a project site: (1) an assessment of California red-legged frog locality records and potential California red-legged frog habitat in and around the project area; and (2) focused field surveys of breeding pools and other associated habitat to determine whether California red-legged frog are likely to be present. Because California red-legged frog are known to use aquatic, riparian, and upland habitat, they may be present in any of these habitat types, depending on the time of year, on any given property. For sites with no suitable aquatic breeding habitat, but where suitable upland dispersal habitat exists, it is difficult to support a negative finding with the results of any survey guidance. Therefore, this Guidance focuses on site assessments and surveys conducted in and around aquatic and riparian habitat (USFWS 2005).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR ACTIONS OVER THE NEXT 5 YEARS The following are recommended actions to promote the recovery of the California red-legged frog over the next five years. 1. Develop a range-wide long-term monitoring plan to evaluate if populations are stable and increasing, including specific long-term study sites. 2. Conduct studies to determine population sizes and locations sufficient to maintain metapopulation structures within core recovery areas. 3. Continue to remove non-native predators such as American bullfrog and other invasive species such as giant reed from California red-legged frog habitat throughout the species range. 4. Continue to promote habitat restoration and reintroduction efforts to restore population redundancy and metapopulation structure particularly in coastal populations south of Santa Barbara County to northern Baja California as well as populations within the San Joaquin Valley and adjacent foothills. 5. Work with private landowners to further conservation of California red-legged frog on private lands in the Sierra Nevada. This may include recording conservation easements on non-protected lands that support populations, acquiring occupied private lands from willing landowners, and increasing surveying efforts on private lands to better understand species distribution and recovery opportunities. 6. Continue to research habitat use and movement of California red-legged frog in the Sierra Nevada. 7. Continue to promote habitat protection and conservation in Mendocino County at the northern extent of the species range, and formally standardize a Service-approved protocol for eDNA surveys so the species status can be accurately studied and distinguished from the similar sympatric species, Northern red-legged frogs (Rana aurora). 8. Investigate “food safety” policies implemented by agricultural commodity buyers, and subsequently farmers, that result in the removal of natural riparian or terrestrial vegetation adjacent to farm fields for the purpose of stemming contaminate outbreaks (USFWS, 2022).

Additional Threshold Information:

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SPECIES ACCOUNT: *Rana muscosa* (Mountain yellow-legged frog)

Species Taxonomic and Listing Information

Commonly-used Acronym: MYLF

Listing Status: Endangered (northern DPS); April 25, 2013. Endangered (southern DPS); July 2, 2002.

Physical Description

The mountain yellow-legged frog is a medium-sized frog, measuring on average 40 to 95 millimeters (mm) (1.5 to 3.75 inches [in.]) snout-vent length. Adult coloration is highly variable; individuals tend to have a mix of brown and yellow coloring on their upper body, but they can also be gray, red, or greenish-brown. Most individuals have dark spots or splotches on the dorsal side; yellow or light-orange undersides; yellow or white throats, sometimes with some dark pigmentation; and pale lemon yellow to sun yellow on the undersurface of the hind limbs. Males are slightly smaller than females, and have darker, larger thumb bases; but otherwise, the sexes are indistinguishable. Tadpoles are usually dark brown on their back and faintly yellow on their underside. They have a flattened body shape and can grow up to 90 mm (3.54 in.) in length (78 FR 24471; CDFG 2011).

Taxonomy

Until recently treated as a single species, the former mountain yellow-legged frog (Rana muscosa) "species complex" has since been divided into two separate species: the mountain yellow-legged frog (Rana muscosa) and the Sierra Nevada yellow-legged frog (Rana sierrae). This determination is consistent with new molecular (mitochondrial DNA), morphological, habitat, and male advertisement call data that recognize these as two distinct species. However, because the majority of research into these species was performed and published under the umbrella "species complex," which until recently treated Rana muscosa and Rana sierrae as a single species, the majority of the information available about these species is only known at the "species complex" level. Mountain yellow-legged frogs closely resemble the Sierra Nevada yellow-legged frog, but can be distinguished by their longer legs. Adults have dorsolateral folds, although they are not prominent, lack vocal sacs, and have smoother tympana and darker toe tips than the foothill yellow-legged frog (Rana boylii) (78 FR 24471; CDFG 2011).

Historical Range

Mountain yellow-legged frogs were historically abundant across much of the higher elevations of the Sierra Nevada. The precise historical ranges of the Sierra Nevada yellow-legged frog and the mountain yellow-legged frog are difficult to determine, because projections must be inferred from museum collections that do not reflect systematic surveys; and historic survey information is very limited. Sierra Nevada yellow-legged frogs occupy the western Sierra Nevada north of the Monarch Divide (in Fresno County) and the eastern Sierra Nevada (east of the crest) in Inyo and Mono Counties. The northern DPS of the mountain yellow-legged frog extends in the western Sierra Nevada from south of the Monarch Divide in Fresno County through portions of the Kern River drainage); the southern DPS of the mountain yellow-legged frog occupies the canyons of the Transverse Ranges in southern California. The northern DPS of the mountain yellow-legged frog ranges from the Monarch Divide in Fresno County, southward through the headwaters of the Kern River Watershed. The ranges of the two frog species in the mountain yellow-legged complex therefore meet each other roughly along the Monarch Divide to the north, and along the crest of the Sierra Nevada to the east (78 FR 24471; CDFG 2011).

Current Range

Currently, mountain yellow-legged frogs exist in montane regions of the Sierra Nevada of California at elevations ranging from 1,370 to 3,660 meters (m) (4,500 to 12,000 feet [ft.]). Sierra Nevada yellow-legged frogs occupy the western Sierra Nevada north of the Monarch Divide (in Fresno County) and the eastern Sierra Nevada (east of the crest) in Inyo and Mono Counties. Researchers have reported disappearances of these species from a large fraction of their historical ranges in the Sierra Nevada, with their distributions currently restricted primarily to publicly managed lands at high elevations, including streams, lakes, ponds, and meadow wetlands in National Forests and National Parks. The most pronounced declines in the mountain yellow-legged frog complex have occurred north of Lake Tahoe in the northernmost 125-kilometer (km) (78-mile [mi.]) portion of the range (Sierra Nevada yellow-legged frog) and south of Sequoia and Kings Canyon National Parks in Tulare County, in the southernmost 50-km (31-mi.) portion, where only a few populations of the northern DPS of the mountain yellow-legged frog remain. Mountain yellow-legged frog populations have persisted in greater density in the National Parks of the Sierra Nevada than in the surrounding U.S. Forest Service (USFS) lands, and the populations that do occur in the National Parks generally exhibit greater abundances than those on USFS lands. Currently, the northern DPS of the mountain yellow-legged frog is discrete from the southern DPS because it is separated from the southern frogs by a 140-mi. (225-km) barrier of unsuitable habitat (78 FR 24471; 79 FR 24255; CDFG 2011).

Critical Habitat Designated

Yes; 4/25/2013.

Legal Description

On August 6, 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

Two units and seven subunits are designated as critical habitat for the northern DPS of the mountain yellowlegged frog. Units are named after the major genetic clades (Vredenburg et al. 2007, p. 361), of which three exist rangewide for the mountain yellow-legged frog, and two are within the northern DPS of the mountain yellow-legged frog in the Sierra Nevada. Distinct units within each clade are designated as subunits.

Unit 4: Northern DPS of the Mountain Yellow-Legged Frog Clade 4 This unit represents a significant portion of the northern DPS of the mountain yellow-legged frog’s range and reflects a core conservation area comprising the most robust remaining populations at higher densities (closer proximity) across the species’ range. Unit 4, including all subunits, is an essential component to the entirety of this critical habitat designation due to the unique genetic and distributional area this unit encompasses. The frog populations within Clade 4 of the northern DPS of the mountain yellowlegged frog distribution face significant threats from habitat fragmentation. The critical habitat within the unit is necessary to sustain viable populations within Clade 4 northern DPS of the mountain yellow-legged frog, which are at very low abundances. Unit 4 is crucial to the species for range expansion and recovery. In addition, Clade 4 includes the only remaining basins with high-density, lake-based populations that are not infected with Bd, and Bd will likely invade these uninfected populations in the near future unless habitat protections and special management considerations are implemented. It is necessary to broadly protect remnant habitat across the range of Clade 4 to facilitate species persistence and recovery. Subunit 4A: Frypan Meadows The Frypan Meadows subunit consists of approximately 1,585 ha (3,917 ac), and is located in Fresno County, California, approximately 4.3 km (2.7 mi) northwest of Highway 180. The Frypan Meadows subunit consists entirely of Federal land, located predominantly within the boundaries of the Kings Canyon National Park, with some overlap into the Monarch Wilderness within the Sequoia National Forest. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the northern DPS of the mountain yellowlegged frog in the Frypan Meadows subunit may require special management considerations or protection due to fish persistence. Subunit 4B: Granite Basin The Granite Basin subunit consists of approximately 1,777 ha (4,391 ac), and is located in Fresno County, California, approximately 3.2 km (2 mi) north of Highway 180. The Granite Basin subunit consists entirely of Federal land, located within the boundaries of the Kings Canyon National Park. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the northern DPS of the mountain yellowlegged frog in the Granite Basin subunit may require special management considerations or protection due to fish persistence. Subunit 4C: Sequoia Kings The Sequoia Kings subunit consists of approximately 67,566 ha (166,958 ac), and is located in Fresno, Inyo and Tulare Counties, California, approximately 18 km (11.25 mi) west of Highway 395 and 4.4 km (2.75 mi) southeast of Highway 180. The Sequoia Kings subunit consists entirely of Federal land, all within Sequoia and Kings Canyon National Parks. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the northern DPS of the mountain yellowlegged frog in the Sequoia Kings subunit may require special management considerations or protection due to the presence of introduced fishes and fish persistence. Subunit 4D: Kaweah River The Kaweah River subunit consists of approximately 3,663 ha (9,052 ac), and is located in Tulare County, California, approximately 2.8 km (1.75 mi) east of Highway 198. The Kaweah River subunit consists entirely of Federal land, all within Sequoia National Park. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the northern DPS of the mountain yellowlegged frog in the

Kaweah River subunit may require special management considerations or protection due to fish persistence.

Unit 5: Northern DPS of the Mountain Yellow-Legged Frog Clade 5 This unit represents the southern portion of the species' range and reflects unique ecological features within the range of the species because it comprises populations that are streambased. Unit 5, including all subunits, is an essential component of the entirety of this critical habitat designation due to the unique genetic and distributional area this unit encompasses. The frog populations within Clade 5 of the northern DPS of the mountain yellowlegged frog's distribution are at very low numbers and face significant threats from habitat fragmentation. The critical habitat within the nit is necessary to sustain viable populations within Clade 5 of the northern DPS of the mountain yellow-legged frog, which are at very low abundances. Unit 5 is crucial to the species for range expansion and recovery. Subunit 5A: Blossom Lakes The Blossom Lakes subunit consists of approximately 2,069 ha (5,113 ac), and is located in Tulare County, California, approximately 0.8 km (0.5 mi) northwest of Silver Lake. The Blossom Lakes subunit consists entirely of Federal land, located within Sequoia National Park and Sequoia National Forest. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the northern DPS of the mountain yellowlegged frog in the Blossom Lakes subunit may require special management considerations or protection due to fish persistence. Subunit 5B: Coyote Creek The Coyote Creek subunit consists of approximately 9,802 ha (24,222 ac), and is located in Tulare County, California, approximately 7.5 km (4.7 mi) south of Moraine Lake. Land ownership within this subunit consists of approximately 9,792 ha (24,197 ac) of Federal land and 10 ha (24 ac) of private land. The Coyote Creek subunit is predominantly within Sequoia National Park and Sequoia and Inyo National Forests, including area within the Golden Trout Wilderness. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the northern DPS of the mountain yellowlegged frog in the Coyote Creek subunit may require special management considerations or protection due to the presence of introduced fishes and recreational activities. Subunit 5C: Mulkey Meadows The Mulkey Meadows subunit consists of approximately 3,175 ha (7,846 ac), and is located in Tulare and Inyo Counties, California, approximately 10 km (6.25 mi) west of Highway 395. The Mulkey Meadows subunit consists entirely of Federal land, all within the Inyo National Forest, including area within the Golden Trout Wilderness. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the northern DPS of the mountain yellowlegged frog in the Mulkey Meadows subunit may require special management considerations or protection due to the presence of introduced fishes, inappropriate grazing activity, and recreational activities.

Primary Constituent Elements/Physical or Biological Features

Critical habitat units are designated for Fresno, Inyo and Tulare Counties, California. Within these areas, the primary constituent elements of the physical or biological features essential to the conservation of the northern DPS of the mountain yellow-legged frog consist of:

(i) Aquatic habitat for breeding and rearing. Habitat that consists of permanent water bodies, or those that are either hydrologically connected with, or close to, permanent water bodies, including, but not limited to, lakes, streams, rivers, tarns, perennial creeks (or permanent plunge pools within intermittent creeks), pools (such as a body of impounded water contained above a natural dam), and other forms of aquatic habitat. This habitat must: (A) For lakes, be of sufficient depth not to freeze solid (to the bottom) during the winter (no less than 1.7 meters (m) (5.6 feet (ft)), but generally greater than 2.5 m (8.2 ft), and optimally 5 m (16.4 ft) or deeper (unless some other refuge from freezing is available)). (B) Maintain a natural flow pattern, including periodic flooding, and have functional community dynamics in order to provide sufficient productivity and a prey base to support the growth and development of rearing tadpoles and metamorphs. (C) Be free of introduced predators. (D) Maintain water during the entire tadpole growth phase (a minimum of 2 years). During periods of drought, these breeding sites may not hold water long enough for individuals to complete metamorphosis, but they may still be considered essential breeding habitat if they provide sufficient habitat in most years to foster recruitment within the reproductive lifespan of individual adult frogs. (E) Contain: (1) Bank and pool substrates consisting of varying percentages of soil or silt, sand, gravel, cobble, rock, and boulders (for basking and cover); (2) Shallower microhabitat with solar exposure to warm lake areas and to foster primary productivity of the food web; (3) Open gravel banks and rocks or other structures projecting above or just beneath the surface of the water for adult sunning posts; (4) Aquatic refugia, including pools with bank overhangs, downfall logs or branches, or rocks and vegetation to provide cover from predators; and (5) Sufficient food resources to provide for tadpole growth and development.

(ii) Aquatic nonbreeding habitat (including overwintering habitat). This habitat may contain the same characteristics as aquatic breeding and rearing habitat (often at the same locale), and may include lakes, ponds, tarns, streams, rivers, creeks, plunge pools within intermittent creeks, seeps, and springs that may not hold water long enough for the species to complete its aquatic life cycle. This habitat provides for shelter, foraging, predator avoidance, and aquatic dispersal of juvenile and adult mountain yellow-legged frogs. Aquatic nonbreeding habitat contains: (A) Bank and pool substrates consisting of varying percentages of soil or silt, sand, gravel, cobble, rock, and boulders (for basking and cover); (B) Open gravel banks and rocks projecting above or just beneath the surface of the water for adult sunning posts; (C) Aquatic refugia, including pools with bank overhangs, downfall logs or branches, or rocks and vegetation to provide cover from predators; (D) Sufficient food resources to support juvenile and adult foraging; (E) Overwintering refugia, where thermal properties of the microhabitat protect hibernating life stages from winter freezing, such as crevices or holes within bedrock, in and near shore; and/or (F) Streams, stream reaches, or wet meadow habitats that can function as corridors for movement between aquatic habitats used as breeding or foraging sites.

(iii) Upland areas. (A) Upland areas adjacent to or surrounding breeding and nonbreeding aquatic habitat that provide area for feeding and movement by mountain yellow-legged frogs. (1) For stream habitats, this area extends 25 m (82 ft) from the bank or shoreline. (2) In areas that contain riparian habitat and upland vegetation (for example, mixed conifer, ponderosa pine, montane conifer, and montane riparian woodlands), the canopy overstory should be sufficiently thin (generally not to exceed 85 percent) to allow sunlight to reach the aquatic habitat and thereby provide basking areas for the species. (3) For areas between proximate (within 300 m (984 ft)) water bodies (typical of some high mountain lake habitats), the upland area extends from the bank or shoreline between such water bodies. (4) Within mesic habitats such as lake and meadow systems, the entire area of physically contiguous or proximate habitat is suitable for dispersal and foraging. (B) Upland areas (catchments) adjacent to and surrounding both breeding and nonbreeding aquatic habitat that provide for the natural hydrologic regime (water quantity) of aquatic habitats. These upland areas should also allow for the maintenance of sufficient water quality to provide for the various life stages of the frog 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 Sierra Nevada yellow-legged frog and northern DPS of the mountain yellow-legged frog may require special management considerations or protection to reduce the following threats: The persistence of introduced trout populations in essential habitat; the risks related to the spread of pathogens; the effects from water withdrawals and diversions; impacts associated with timber harvest and fuels reduction activities; impacts associated with inappropriate livestock grazing; and intensive use by recreationists, including packstock camping and grazing.

Conservation actions that could ameliorate the threats described above include (but are not limited to) nonnative fish eradication; installation of fish barriers; modifications to fish stocking practices in certain water bodies; physical habitat restoration; and responsible management practices covering potentially incompatible activities, such as timber harvest and fuels management, water supply development and management, inappropriate livestock grazing, packstock grazing, and other recreational uses. These management practices will protect the PCEs for the mountain yellow-legged frog by reducing the stressors currently affecting population viability. Additionally, management of critical habitat lands will help maintain the underlying habitat quality, foster recovery, and sustain populations currently in decline.

Life History

Food/Nutrient Resources

Food Source

Juvenile: Algae, diatoms, detritus, conspecific eggs, and adult/tadpole carcasses.

Adult: Terrestrial insects, adult aquatic insects, benthic macroinvertebrates, and amphibians (tadpole/adult).

Competition

Juvenile: None

Adult: Because of their need to overwinter underwater, mountain yellow-legged frogs and introduced (stocked) trout are both typically restricted to large, deep water bodies. However, the majority of lentic water bodies in the Sierra Nevada are relatively small and shallow. Therefore, the critical habitat necessary for both frogs and trout to overwinter is relatively uncommon. With the widespread introduction of nonnative trout, nearly all large, deep lakes that could provide suitable overwintering habitat for frogs are now occupied by introduced trout. In addition to their role as predators of mountain yellow-legged frogs, trout are also competitors for the same invertebrate species that frogs rely on for food (e.g., terrestrial invertebrates and adult stages of aquatic insects). In Sierra Nevada lakes, large, conspicuous invertebrate taxa are rare or absent in trout-containing lakes but are relatively common in lakes without trout. The direct impacts of trout predation on invertebrates can have a negative effect on frogs via competition for invertebrate prey; and can alter lake nutrient cycles, resulting in negative impacts to frogs and other native species (CDFG 2011).

Food/Nutrient Narrative

Juvenile: Mountain yellow-legged frogs are omnivorous, feeding as tadpoles on algae, diatoms, and detritus. Tadpoles forage for prey at the bottoms of lakes, ponds, and streams, in shallow waters. During winter, tadpoles remain in warmer water below the thermocline; in the spring, when warmer days raise surface water temperatures, they move to shallow, near-shore water, retreating during the late afternoon and evening to offshore waters that are less subject to night cooling (78 FR 24471; CDFG 2011). Tadpoles may take more than 1 year, and often require 2 to 4 years, to reach metamorphosis (transformation from tadpoles to frogs), depending on local climate conditions and site-specific variables (78 FR 24471; CDFG 2011).

Adult: Mountain yellow-legged frogs are omnivorous, feeding in adulthood on a diet of terrestrial and aquatic insects and macro invertebrates, other amphibians, and the occasional cannibalism of eggs and tadpole/adult carcasses. Adults forage for prey at the bottoms of lakes, ponds, and streams; in shallow waters; and onshore.As adults, frogs maximize body temperatures during a majority of the day by basking in the sun, moving between water and land, and concentrating in the warmer shallows along the shoreline. As temperatures decrease in the fall, frogs become less active and move to overwintering habitats (78 FR 24471; CDFG 2011).With the widespread introduction of nonnative trout, nearly all large, deep lakes that could provide suitable overwintering habitat for frogs are now occupied by introduced trout. In addition to their role as predators of mountain yellow-legged frogs, trout are also competitors for the same invertebrate species that frogs rely on for food. The direct impacts of trout predation on invertebrates can have a negative effect on frogs via competition for invertebrate prey; and can alter lake nutrient cycles, resulting in negative impacts to frogs and other native species (CDFG 2011).

Reproductive Strategy

Adult: Demersal spawning.

Lifespan

Adult: Longevity of adults is unknown, but adult survivorship from year to year is very high under normal circumstances. Mountain yellow-legged frogs are presumed to be long-lived amphibians (78 FR 24471; CDFG 2011).

Dependency on Other Individuals or Species

Adult: None

Breeding Season

Adult: Adults emerge from overwintering sites at spring thaw or snowmelt and commence breeding soon thereafter—between April and May at lower elevations and progressively later (June and July) at higher elevations (CDFG 2011).

Key Resources Needed for Breeding

Adult: Lake depth is an important attribute in defining habitat suitability for mountain yellow-legged frogs. Because tadpoles must overwinter multiple years before metamorphosis, successful breeding sites are located in (or connected to) lakes and ponds that do not dry out in the summer, and also are deep enough that they do not completely freeze or become oxygen depleted (anoxic) in winter (78 FR 24471).

Other Reproductive Information

Adult: Adult mountain yellow-legged frogs breed in the shallows of ponds or in inlet streams. Adults emerge from overwintering sites immediately following snowmelt, and will even move over ice to reach breeding sites. Mountain yellow-legged frogs deposit their eggs underwater in clusters, which they attach to rocks, gravel, or vegetation, or which they deposit under banks. Mountain yellow-legged frogs deposit their eggs in globular clumps, which are often somewhat flattened and roughly 2.5 to 5 centimeters (cm) (1 to 2 in.) in diameter. Eggs have three firm, jelly-like, transparent envelopes surrounding a grey-tan or black vitelline (egg yolk) capsule. Egg development is temperature-dependent (78 FR 24471; CDFG 2011).

Reproduction Narrative

Adult: Adults emerge from overwintering sites at spring thaw or snowmelt and commence breeding soon thereafter—between April and May at lower elevations and progressively later (June and July) at higher elevations (CDFG 2011). Eggs are deposited underwater in the shallows of ponds or in inlet streams in clusters, which they attach to rocks, gravel, or vegetation, or which they deposit under banks. Because tadpoles must overwinter multiple years before metamorphosis, successful breeding sites are located in (or connected to) lakes and ponds that do not dry out in the summer, and also are deep enough that they do not completely freeze or become oxygen depleted (anoxic) in winter.The eggs are deposited in globular clumps, which are often somewhat flattened and roughly 2.5 to 5 cm (1 to 2 in.) in diameter (78 FR 24471; CDFG 2011). Clutch size varies from 15 to 350 eggs per egg mass. Egg hatching time ranges from 16 to 21 days at temperatures of 5 to 13.5 °C (41 to 56°F). The time required to reach reproductive maturity in mountain yellow-legged frogs is thought to vary between 3 and 4 years post-metamorphosis. In combination with the extended amount of time as a tadpole before metamorphosis, it may take 5 to 8 years for mountain yellow-legged frogs to begin reproducing (78 FR 24471; CDFG 2011).Longevity of adults is unknown, but adult survivorship from year to year is very high under normal circumstances. Mountain yellow-legged frogs are presumed to be long-lived amphibians (78 FR 24471; CDFG 2011).

Habitat Type

Juvenile: See adult life stage.

Adult: Montane regions of the Sierra Nevada of California; lakes, ponds, marshes, meadows, and streams at elevations ranging from 1,370 to 3,660 m (4,500 to 12,000 ft.) (78 FR 24471; CDFG 2011).

Habitat Vegetation or Surface Water Classification

Juvenile: See adult life stage.

Adult: Lakes, ponds, tarns (small steep-banked mountain lake or pool), streams, marshes, and meadows (78 FR 24471; CDFG 2011).

Dependencies on Specific Environmental Elements

Juvenile: See adult life stage.

Adult: Mountain yellow-legged frogs are highly aquatic; they are generally not found more than 1 m (3.3 ft.) from water (78 FR 24471; CDFG 2011). Adults typically are found sitting on rocks along the shoreline, usually where there is little or no vegetation. Although mountain yellow-legged frogs may use a variety of shoreline habitats, both tadpoles and adults are less common at shorelines that drop abruptly to a depth of 60 cm (2 ft.) than at open shorelines that gently slope up to shallow waters of only 5 to 8 cm (2 to 3 in) in depth (78 FR 24471). At lower elevations within their historical range, these species are known to be associated with rocky streambeds and wet meadows surrounded by coniferous forest. Streams used by adults vary from streams having high gradients and numerous pools, rapids, and small waterfalls; to streams with low gradients and slow flows, marshy edges, and sod banks. Aquatic substrates vary from bedrock to fine sand, rubble (rock fragments), and boulders. Mountain yellow-legged frogs appear absent from the smallest creeks, probably because these creeks have insufficient depth for adequate refuge and overwintering habitat. Sierra Nevada yellow-legged frogs do use stream habitats, especially the remnant populations in the northern part of their range. At higher elevations, these species occupy lakes, ponds, tarns (small steep banked mountain lake or pool), and streams. Mountain yellow-legged frogs in the Sierra Nevada are most abundant in high-elevation lakes and slow-moving portions of streams. The borders of alpine (above the tree line) lakes and mountain meadow streams used by mountain yellow-legged frogs are frequently grassy or muddy. This differs from the sandy or rocky shores inhabited by mountain yellow-legged frogs in lower elevation streams. Both adult and tadpole mountain yellow-legged frogs overwinter for up to 9 months in the bottoms of lakes that are at least 1.7 m (5.6 ft.) deep; however, overwinter survival may be greater in lakes that are at least 2.5 m (8.2 ft.) deep (78 FR 24471). Where water depths range from 0.2 m (0.7 ft.) to 1.5 m (5 ft.), the availability of rock crevices, holes, and ledges near shore offer protection to overwintering frogs when water bodies freeze over completely (78 FR 24471).

Geographic or Habitat Restraints or Barriers

Juvenile: See adult life stage.

Adult: Highly aquatic.

Spatial Arrangements of the Population

Juvenile: See adult life stage.

Adult: Clumped

Environmental Specificity

Juvenile: See adult life stage.

Adult: Narrow

Tolerance Ranges/Thresholds

Juvenile: See adult life stage.

Site Fidelity

Juvenile: See adult life stage.

Adult: High

Dependency on Other Individuals or Species for Habitat

Juvenile: See adult life stage.

Adult: None

Habitat Narrative

Juvenile: See adult life stage.

Adult: Mountain yellow-legged frogs currently exist in montane regions of the Sierra Nevada of California in lakes, ponds, marshes, meadows, and streams at elevations ranging from 1,370 to 3,660 m (4,500 to 12,000 feet ft.). Mountain yellow-legged frogs are highly aquatic, are generally not found more than 1 m (3.3 ft.) from water (78 FR 24471; CDFG 2011), and display strong site fidelity, returning to the same overwintering and summer habitats from year to year (78 FR 24471).Both adult and tadpole mountain yellow-legged frogs overwinter for up to 9 months in the bottoms of lakes that are at least 1.7 m (5.6 ft.) deep; however, overwinter survival may be greater in lakes that are at least 2.5 m (8.2 ft.) deep (78 FR 24471). Where water depths range from 0.2 m (0.7 ft.) to 1.5 m (5 ft.), the availability of rock crevices, holes, and ledges near shore offer protection to overwintering frogs when water bodies freeze over completely (78 FR 24471).

Dispersal/Migration

Motility/Mobility

Juvenile: See adult life stage.

Adult: Low due to dependence on aquatic habitats.

Dispersal

Juvenile: See adult life stage.

Adult: Low

Dependency on Other Individuals or Species for Dispersal

Juvenile: See adult life stage.

Adult: None

Dispersal/Migration Narrative

Juvenile: See adult life stage.

Adult: Mountain yellow-legged frogs are highly aquatic and generally not found more than 1 m (3.3 ft.) from water. Movements are typically localized, consisting of dispersal between selected breeding, feeding, and overwintering habitats during the course of a year, but can also lead to the re-colonization of sites where frogs have been extirpated previously. In aquatic habitats of high mountain lakes, mountain yellow-legged frog adults typically move only a few hundred meters (few hundred yards), but single-season distances of up to 3.3 km (2.05 mi.) have been recorded along streams (78 FR 24471). Regular overland movements of more than 66 m (217 ft.) have been recorded, with individuals ranging as far 400 m (1,300 ft.) from water. During the overwintering period, adults have been observed along stream habitats more than 22 m (71 ft.) from the water (78 FR 24471; CDFG 2011).Regionally, mountain yellow-legged frogs are thought to exhibit a metapopulation structure; metapopulations are spatially separated population subunits within migratory distance of one another, allowing individuals to interbreed among subunits and populations to become reestablished if they are extirpated (78 FR 24471).

Additional Life History Information

Juvenile: See adult life stage.

Adult: The travel of adults through aquatic and dry land habitats also allows the re-colonization of sites from which frog populations were extirpated. For example, following the disappearance or active removal of nonnative trout from lakes, frogs rapidly recolonized these sites from nearby source population (CDFG 2011).

Population Information and Trends

Population Trends:

Decreasing

Species Trends:

Decreasing

Population Growth Rate:

Declining

Number of Populations:

19 extant populations (USFWS, 2024)

Population Size:

Remaining populations are generally very small; estimates range from losses of between 69 to 93 percent of historically occupied habitat (79 FR 24255).

Resistance to Disease:

Low

Adaptability:

Low

Additional Population-level Information:

Range-wide, declines of mountain yellow-legged frog populations were estimated at around one-half of historical populations by the end of the 1980s. Between 1988 and 1991, a resurvey of sites known historically (surveys from 1955 through 1979) to support mountain yellow-legged frogs detected frogs at 19.4 percent of historical sites. During 2002, a resurvey of 302 water bodies known to be occupied by mountain yellow-legged frogs between 1995 and 1997, and 744 sites where frogs were not previously detected, found frogs at 59 percent of the previously occupied sites, whereas 8 percent of previously unoccupied sites were colonized. These data suggest an extirpation rate five to six times higher than the colonization rate in this study area.Documented extirpations appear to occur nonrandomly across the landscape, are typically spatially clumped, and involve the disappearance of all or nearly all of the mountain yellow-legged frog populations in a watershed. CDFW assessed data from sites where multiple surveys were completed after 1995 (at least 5 years apart), and found that the Sierra Nevada yellow-legged frog was not detected at 45 percent of sites where they previously had been confirmed.To summarize population trends over the available historical record, estimates range from losses between 69 to 93 percent of Sierra Nevada yellow-legged frog populations. Range-wide reduction has diminished the number of watersheds that support mountain yellow-legged frogs—at a conservative estimate of 44 percent for Sierra Nevada yellow-legged frogs and at least 59 percent in the case of northern DPS of the mountain yellow-legged frogs, to as high as 97 percent of watersheds for the mountain yellow-legged frog complex across the Sierra Nevada. Remaining populations are much smaller than historical norms, and the density of populations per watershed has declined substantially; as a result, many watersheds currently support single metapopulations at low abundances.CDFW used historical localities from museum records covering 1899 through 1994, updated with recent locality information from additional survey data (1995 through 2010), and failed to detect any extant frog populations (within 1 km [0.63 mi.]), a metric used to capture interbreeding individuals in metapopulations) at 220 of 318 historical Sierra Nevada yellow-legged frog localities. This calculates to an estimated loss of 69 percent of Sierra Nevada yellow-legged frog metapopulations from historical occurrences.In the Sierra Nevada, 44 percent of watersheds historically used by Sierra Nevada yellow-legged frogs no longer support extant populations. However, this watershed-level survey methodology is not a good indicator of population changes, because a watershed is counted as recently occupied if a single individual (at any life stage) is observed in the entire watershed even though several individual populations may have been lost. Therefore, these surveys likely underestimate population declines. Many watersheds support only a single extant metapopulation, which occupies one to several adjacent water bodies (79 FR 24255).

Population Narrative:

Monitoring efforts and research studies have documented substantial declines of mountain yellow-legged frog populations in the Sierra Nevada. The number of extant populations has declined greatly over the last few decades. Remaining populations are patchily scattered throughout the historical range. Documented extirpations appear to occur nonrandomly across the landscape, are typically spatially clumped, and involve the disappearance of all or nearly all of the mountain yellow-legged frog populations in a watershed. Over the available historical record, estimates range from losses between 69 to 93 percent. Range-wide reduction has diminished the number of watersheds that support mountain yellow-legged frogs (R. sierrae), at a conservative estimate of 59 percent. Remaining populations are much smaller than historical norms, and the density of populations per watershed has declined substantially; as a result, many watersheds currently support single metapopulations at low abundances. Remaining populations are generally very small, and available information indicates that the rates of population decline have not abated, and they have likely accelerated during the 1990s into the 2000s (79 FR 24255). Southern DPS: Southern Rana muscosa, which historically was widely distributed in at least 166 known populations across four mountain ranges in southern California, are currently considered to be extant in 10 small populations distributed disproportionately across three mountain ranges. Most populations are isolated in the headwaters of streams or tributaries due to the extensive distribution of predatory nonnative trout in historical habitat; thus, it exists in a highly fragmented environment. Such isolation and fragmentation followed by the prevention of successful recolonization increases the potential for extirpation of the remaining populations (USFWS, 2018). Mountain yellow-legged frogs (Rana muscosa) are medium-sized amphibians in the family Ranidae (true frogs). Adult mountain yellow-legged frogs are about 40 to 80 millimeters (mm) [1.5 to 3 inches (in)] from snout to urostyle (the pointed bone at the base of the backbone) (Zweifel 1955, p. 230; Jennings and Hayes 1994, p. 74). The Southern California Distinct Population Segment (DPS) of Rana muscosa, which historically was widely distributed in at least 166 known populations across 4 mountain ranges in southern California, are currently considered to be extant in 19 small populations distributed disproportionately across 3 mountain ranges (Figure 1). Most populations are isolated in the headwaters of streams or tributaries due to the extensive distribution of predatory nonnative trout in historical habitat; thus, it exists in a highly fragmented environment (USFWS, 2024).

Threats and Stressors

Stressor: Habitat destruction (recreation)
Exposure: See narrative.
Response: See narrative.
Consequence: See narrative.
Narrative: Recreational foot traffic in naturally stressed Sierra Nevada ecosystems like riparian areas tramples the vegetation, compacts the soils, and can physically damage the streambanks. Hiking, horse, bicycle, or off-highway motor vehicle trails compact soils in riparian habitat, and can lower the water table and cause increased erosion. The recreational activity of anglers at high mountain lakes can be locally intense in the Sierra Nevada, with most regions reporting a level of use greater than the fragile lakeshore environments can withstand. Recreational activities are the fastest growing use of National Forests. Therefore, their impacts on the mountain yellow-legged frog complex are likely to continue and to increase. Currently, recreational activities are considered a threat of low significance to the species' habitat overall.

Stressor: Habitat destruction (habitat modification due to introduction of trout to historically fishless areas)
Exposure: See narrative.
Response: See narrative.
Consequence: See narrative.
Narrative: The presence of trout from current and historical stocking for the maintenance of a sport fishery is documented to have a significant detrimental impact to mountain yellow-legged frog populations. This anthropogenic activity has community-level effects and constitutes the primary detrimental impact to mountain yellow-legged frog habitat and species viability. Prior to extensive trout-planting programs, almost all streams and lakes in the Sierra Nevada at elevations above 1,800 m (6,000 ft.) were fishless. Today, brook trout (Salvelinus fontinalis),

brown trout (Salmo trutta), rainbow trout (Oncorhynchus mykiss), and other trout species assemblages have been planted in most streams and lakes of the Sierra Nevada. Presently, fish stocking as a practice is widespread throughout the range of both species of mountain yellow-legged frogs.Trout both compete for limited resources and directly prey on mountain yellow-legged frog tadpoles and adults. The presence of these fish decimates frog populations through competition and predation, leading to the isolation of populations and preventing recolonization by frogs. Fundamentally, this has removed deeper lakes from being mountain yellow-legged frog habitat at a landscape scale. Introduced trout have also negatively impacted mountain yellow-legged frogs over much of the Sierra Nevada because fish eat aquatic flora and fauna, including amphibians and invertebrates—the same resource base that sustains the growth of both frogs and trout. Although most of the impacts occurred historically, the impact on the biogeographic (population/metapopulation) integrity of the species will be long-lasting. Currently, habitat degradation and fragmentation by fish is considered a highly significant and prevalent threat to the persistence and recovery of the species.

Stressor: Habitat destruction (dams and water diversions)
Exposure: See narrative.
Response: See narrative.
Consequence: See narrative.
Narrative: Numerous reservoirs, dams, and water diversions have been constructed within the ranges of the mountain yellow-legged frog complex and altered aquatic habitats in the Sierra Nevada. The combination of these features has reduced habitat suitability within the range of the species by creating migration barriers and altering local hydrology. This stressor causes considerable habitat fragmentation and direct habitat loss in those areas where water projects were constructed and are operating. Dams alter the temperature and sediment load of the rivers they impound. Dams, water diversions, and their associated structures also alter the natural flow regime with unseasonal and fluctuating releases of water. These features may create habitat conditions unsuitable for native amphibians both upstream and downstream of dams, and they may act as barriers to movement by dispersing juvenile and migrating adult amphibians.Where dams act as barriers to mountain yellow-legged frog movement, they effectively prevent genetic exchange between populations and the recolonization of vacant sites. Water diversions may remove water from mountain yellow-legged frog habitat and adversely impact breeding success and adult survivorship. This results in physical reduction in habitat area and potentially lowers water levels to the extent that the entire water column freezes in the winter, thereby removing aquatic habitat altogether. Given the amount of water development in the historical ranges of mountain yellow-legged frogs, these factors likely have contributed to population declines; and ongoing management and habitat fragmentation will continue to pose a risk to the species. The magnitude of such impacts would increase if long droughts become more frequent in the future, or if increasing diversions and storage facilities are constructed and implemented to meet growing needs for water and power. Currently, dams and water diversions are considered a moderate, prevalent threat to the persistence and recovery of the species.

Stressor: Habitat destruction (livestock use/grazing)
Exposure: See narrative.
Response: See narrative.
Consequence: See narrative.
Narrative: Grazing reduces the suitability of habitat for mountain yellow-legged frogs by reducing its capability to sustain frogs and facilitate dispersal and migration, especially in stream areas.

The impact of this stressor to mountain yellow-legged frogs is ongoing, but of relatively low importance as a limiting factor on extant populations. Although this stressor may have played a greater role historically, leading in part to range-wide reduction of the species, the geographic extent of livestock grazing activity in current mountain yellow-legged frog habitat does not encompass the entire range of the species.For mountain yellow-legged frogs, livestock grazing activity is likely a minor prevalent threat to currently extant populations, although in certain areas it may exacerbate habitat fragmentation already facilitated by the introduction of trout. This threat is likely more one of historical significance. Although it may be a factor in certain allotments with active grazing and extant populations, range-wide it is likely not a significant risk factor, because many populations persist outside of actively grazed areas.

Stressor: Habitat destruction (packstock use)
Exposure: See narrative.
Response: See narrative.
Consequence: See narrative.
Narrative: Packstock grazing is the only grazing currently permitted in the National Parks of the Sierra Nevada. Use of packstock in the Sierra Nevada has increased since World War II. Packstock use is likely a threat of low significance to mountain yellow-legged frogs at the current time, except on a limited, site-specific basis. As California’s human population increases, the impact of recreational activities, including packstock use and riding in the Sierra Nevada, are projected to increase. This activity may pose a risk to some remnant populations of frogs and, in certain circumstances, a hindrance to recovery (78 FR 24471).

Stressor: Habitat destruction (roads and timber harvest)
Exposure: See narrative.
Response: See narrative.
Consequence: See narrative.
Narrative: Activities that alter the terrestrial environment (such as road construction and timber harvest) may impact amphibian populations in the Sierra Nevada. These impacts are understandably in proportion to the magnitude of the alteration to the environment. Road construction and timber harvest were likely of greater significance historically, and may have acted to reduce the species’ range prior to the more recent detailed studies and systematic monitoring that have quantified and documented these losses. Timber harvest activities remove vegetation and cause ground disturbance and compaction, making the ground more susceptible to erosion, which could potentially damage frog breeding habitat downstream; and may alter the annual hydrograph, possibly lowering the water table. This erosion increases siltation downstream that could potentially damage mountain yellow-legged frog breeding habitat; and contribute to habitat fragmentation, limiting amphibian movement.Currently, most of the mountain yellow-legged frog populations occur in National Parks or designated wilderness areas where timber is not harvested. Other mountain yellow-legged frog populations outside these areas are above the timberline, so timber harvest activity is not expected to affect the majority of extant mountain yellow-legged frog populations. There remain some mountain yellow-legged frog populations in areas where timber harvests occur or may occur in the future. Roads also exist within the range of the mountain yellow-legged frog, and more may be constructed. However, neither of these factors has been implicated as an important contributor to the decline of this species. It is likely a minor prevalent threat to mountain yellow-legged frogs factored across the range of the species (78 FR 24471).

Stressor: Habitat destruction (fire and fire management activities)
Exposure: See narrative.
Response: See narrative.
Consequence: See narrative.
Narrative: Mountain yellow-legged frogs are generally found at high elevations in wilderness areas and National Parks where vegetation is sparse and fire suppression activities are infrequently implemented. Where such activities may occur, potential impacts to the species resulting from fire management activities include habitat degradation through water drafting (taking of water) from occupied ponds and lakes; erosion and siltation of habitat from construction of fuel breaks; and contamination by fire retardants from chemical fire suppression.It is not known what impacts fire and fire management activities have had on historical populations of mountain yellow-legged frogs. When a large fire does occur in occupied habitat, mountain yellow-legged frogs are susceptible to direct mortality (leading to significantly reduced population sizes) and indirect effects (habitat alteration and reduced breeding habitat). It is possible that fire has caused localized extirpations in the past. However, because the mountain yellow-legged frog generally occupies high-elevation habitat, fire is likely not a significant risk to this species over much of its current range (78 FR 24471).

Stressor: Predation
Exposure: See narrative.
Response: See narrative.
Consequence: See narrative.
Narrative: The most prominent predator of mountain yellow-legged frogs is introduced trout, whose significance is well-established because it has been repeatedly observed that nonnative fishes and frogs rarely coexist; and it is known that introduced trout can and do prey on all frog life stages. The multiple-year tadpole stage of the mountain yellow-legged frog and the fact that all life stages are highly aquatic increases the frog's susceptibility to predation by trout (where they co-occur) throughout its lifespan. Introduced trout are effective predators on mountain yellow-legged frog tadpoles, and the introduction of trout is the most likely reason for the decline of the mountain yellow-legged frog complex. This threat is a significant, prevalent risk to mountain yellow-legged frogs range-wide, and it will persist into the future (78 FR 24471).

Stressor: Disease
Exposure: See narrative.
Response: See narrative.
Consequence: See narrative.
Narrative: Over roughly the last 2 decades, pathogens have been associated with amphibian population declines, mass die-offs, and even extinctions worldwide. One pathogen strongly associated with dramatic declines on all five continents is the chytrid fungus, Batrachochytrium dendrobatidis (Bd). This chytrid fungus has now been reported in amphibian species worldwide. Bd is now widespread throughout the Sierra Nevada and, although it has not infected all populations at this time, it is effectively a serious and substantial threat range-wide to the mountain yellow-legged frog complex.Other diseases that may be present within the range of the mountain yellow-legged frog have also been reported as adversely affecting amphibian species. These include red-leg disease, caused by the bacterial pathogen Aeromonas hydrophila and other pathogens; Saprolegnia, a globally distributed fungus that commonly attacks all life stages of fishes (especially hatchery-reared fishes) and, more recently, amphibian species; ranaviruses (Family Iridoviridae); and pathogens such as Aeromonas hydrophila.The contribution of Bd as an

environmental stressor and limiting factor on mountain yellow-legged frog population dynamics is currently extremely high, and it poses a significant future threat to remnant uninfected populations in the southern Sierra Nevada. Its effects are most dramatic following the epidemic stage as it spreads across newly infected habitats; massive die-off events follow the spread of the fungus, and it is likely that survival through metamorphosis is substantially reduced even years after the initial epidemic. The relative impact from other diseases and the interaction of other stressors and disease on the immune systems of mountain yellow-legged frogs remains poorly documented to date (78 FR 24471).

Stressor: The inadequacy of existing regulatory mechanisms
Exposure: See narrative.
Response: See narrative.
Consequence: See narrative.
Narrative: The Wilderness Act of 1964 (16 United States Code [U.S.C.] 1131 et seq.) established a National Wilderness Preservation System made up of federally owned areas designated by Congress as ‘‘wilderness’’ for the purpose of preserving and protecting designated areas in their natural condition. A large number of mountain yellow-legged frog locations occur in wilderness areas managed by the USFS and National Park Service and, therefore, are afforded protection from direct loss or degradation of habitat by some human activities (such as development, commercial timber harvest, road construction, and some fire management actions). Livestock grazing and fish stocking are both permitted in designated wilderness areas.Under the National Forest Management Act of 1976, as amended (NFMA) (16 U.S.C. 1600 et seq.), the USFS is tasked with managing National Forest lands based on multiple-use, sustained-yield principles; and implementing land and resource management plans (LRMP) on each National Forest to provide for a diversity of plant and animal communities. On April 9, 2012, the USFS published a final rule (77 FR 21162) amending 36 Code of Federal Regulations (CFR) 219 to adopt new National Forest System land management regulations to guide the development, amendment, and revision of LRMPs for all Forest System lands. The 2012 planning rule requires that the USFS maintain viable populations of species of conservation concern at the discretion of regional foresters. This rule could thereby result in removal of the limited protections that are currently in place for mountain yellow-legged frogs under the Sierra Nevada Forest Plan Amendment (SNFPA), as described below.In 2001, a record of decision was signed by the USFS for the Sierra Nevada Forest Plan Amendment, based on the final environmental impact statement for the SNFPA effort and prepared under the 1982 NFMA planning regulations. Relevant to the mountain yellow-legged frog complex, the Record of Decision for SNFPA aims to protect and restore aquatic, riparian, and meadow ecosystems, and to provide for the viability of associated native species through implementation of an aquatic management strategy. If these goals of the aquatic management strategy are pursued and met, threats to the mountain yellow-legged frog complex resulting from habitat alterations could be reduced. However, the aquatic management strategy is a generalized approach that does not contain specific implementation timeframes or objectives, and it does not provide direct protections for the mountain yellow-legged frog. Additionally, as described above, the April 9, 2012, final rule (77 FR 21162) that amended 36 CFR 219 to adopt new National Forest System land management planning regulations could result in removal of the limited protections that are currently in place for mountain yellow-legged frogs under the SNFPA.The Federal Power Act of 1920, as amended (FPA) (16 U.S.C. 791 et seq.) was enacted to regulate nonfederal hydroelectric projects to support the development of rivers for energy generation and other beneficial uses. The FPA does not mandate protections of habitat or enhancements for fish and wildlife species, but provides a mechanism for resource agency

recommendations that are incorporated into a license at the discretion of the Commission. The FPA provides for the issuance of a license for the duration of up to 50 years, and the FPA contains no provision for modification of the project for the benefit of species, such as mountain yellow-legged frogs, before a current license expires. Numerous mountain yellow-legged frog populations occur in developed and managed aquatic systems (such as reservoirs and water diversions) operated for the purpose of power generation and regulated by the FPA.The California Endangered Species Act (CESA) (California Fish and Game Code, section 2080 et seq.) prohibits the unauthorized take of state-listed endangered or threatened species. In 2013, the California Fish and Game Commission officially listed the Sierra Nevada yellow-legged frog as a threatened species. However, CESA is not expected to provide adequate protection for the mountain yellow-legged frog complex, given that the California Department of Fish and Wildlife (CDFW) has currently approved take authorization for the statewide stocking program under CESA for fish hatchery and stocking activities.CDFW is in the process of developing management plans for basins within the range of the Sierra Nevada yellow-legged frog and the northern DPS of mountain yellow-legged frog. The objectives of the basin plans specific to the mountain yellow-legged frog include management in a manner that maintains or restores native biodiversity and habitat quality, supports viable populations of native species, and provides for recreational opportunities that consider historical use patterns. Under this approach, some lakes are managed primarily for the mountain yellow-legged frogs and other amphibian resources, with few or no angling opportunities, while lakes with high demand for recreational angling are managed primarily for angling purposes (78 FR 24471).

Stressor: Climate change
Exposure: See narrative.
Response: See narrative.
Consequence: See narrative.
Narrative: In the Sierra Nevada ecoregion, climate models predict temperature change (warming) which would result in warmer winters, earlier spring snowmelt, and higher summer temperatures; these conditions would lead to higher winter streamflows, earlier runoff, and reduced spring and summer streamflows, with increasing severity in the southern Sierra Nevada. The results of such climate change to the mountain yellow-legged frog include an increased severity of some winter storms that may freeze lakes to greater depths, resulting in longer hibernation times, less time available for feeding/breeding, and a subsequent increase in stress levels; a decrease in the availability of deeper lakes that once supported frog populations (but now harbor introduced trout), leading to a loss of breeding/feeding habitat and a greater frequency of tadpole stranding and death; change in breeding cues toward earlier in the year, leading to longer growth and development periods and larger individuals, but also an increase in frequency of tadpole (or egg) exposure to killing frosts during variable spring weather; an alteration to invertebrate communities, which could have a negative impact on the mountain yellow-legged frog prey base; an increase in fire intensity and magnitude, resulting in changes to vegetation communities, water chemistry, and nutrient input and subsequent stress to individuals; changes in the virulence, distribution, and vectors of pathogens, rendering individuals more susceptible to disease; and changes in/barriers to dispersal, emigration, and immigration, preventing adaptive range shifts, recolonization, and genetic exchange. Climate change represents a substantial future threat to the persistence of mountain yellow-legged frog populations (78 FR 24471).

Stressor: Small population size

Exposure: See narrative.
Response: See narrative.
Consequence: See narrative.
Narrative: Remaining populations for both the Sierra Nevada yellow-legged frog and the mountain yellow-legged frog are small in many localities. About 90 percent of watersheds have fewer than 10 adults, and 80 percent have fewer than 10 subadults and 100 tadpoles. Remnant populations in the far northern extent of the range for the Sierra Nevada yellow-legged frog (from Lake Tahoe north) and the southern extent of the Sierran populations of the mountain yellow-legged frog (south of Kings Canyon National Park) currently also exhibit very low abundances. The combination of low numbers with the other extant stressors of disease, fish persistence, and potential for climate extremes could have adverse consequences for the mountain yellow-legged frog complex as populations approach the Allee threshold. Small population size is currently a significant threat to most populations of mountain yellow-legged frogs across the range of the species (78 FR 24471).

Recovery

Reclassification Criteria:
Southern DPS: Factor A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range In order to downlist southern Rana muscosa to threatened status, threats to the species due to degraded or limited habitat must be reduced. This will have been accomplished if the following have occurred: A.1: Impacts to southern Rana muscosa due to recreational activity in occupied habitat are effectively managed, avoided or minimized. A.2: Potential impacts to southern Rana muscosa due to cannabis plantations are monitored and minimized. A.3: Appropriate vegetation management projects are designed and implemented to help minimize the potential impacts of wildfire on southern Rana muscosa. Individual frogs are translocated or removed from the wild and brought into captivity to avoid severe post-fire impacts, as appropriate (USFWS, 2018b).

Southern DPS: Factor C: Disease or Predation C.1: Nonnative predators are absent from areas occupied by southern Rana muscosa. Nonnative predators are removed from downstream areas below occupied southern Rana muscosa occurrences as well as from re-establishment sites to allow for population expansion. An “occurrence” is defined as a location at which the species is detected. Effective barriers are established and maintained, as appropriate. C.2: Impacts to southern Rana muscosa from disease are appropriately understood and managed (USFWS, 2018b).

Southern DPS: Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence E.1: The threat of small population size is addressed. At least 20 occurrences1 will exist with a minimum of 50 adults per occurrence or allowances for periodic translocations or movements of southern Rana muscosa to augment populations smaller than 50 adults (Appendix I and II). To ensure redundancy, at least five occurrences will need to be occupied in each Management Unit. Monitoring will detect these numbers for at least 5 consecutive years and document reproduction and recruitment (USFWS, 2018b).

Recovery Priority Number: 3

Delisting Criteria:

Southern DPS: In order to delist southern Rana muscosa the following additional criteria must be met: Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence E.2: Genetic studies document that the mountain yellow-legged frog can sustain genetic diversity in the long-term, including consideration of minimum effective population size. E.3: The potential effects of contaminants, ultraviolet radiation, pesticides, and acid precipitation have been considered and appropriately addressed. E.4: In addition to the downlisting criteria, at least one occurrence with a minimum population size of 500 adults shall occur within each of the three Management Units mentioned above, to help increase resiliency of each unit and ensure the long term genetic representation of the species through protection from stochastic events such as wildfire. Monitoring will detect these numbers for at least 5 consecutive years and document reproduction and recruitment (USFWS, 2018b).

Recovery Actions:

- Southern DPS: Conduct research to inform management actions where appropriate throughout the range of the species. There are numerous gaps in our understanding of mountain yellow-legged frog biology and ecology. Additional information will help us make informed management decisions throughout the range of the species, including in the planning and implementation of Recovery Actions 3 through 6 (below). Research is needed to identify suitable habitat conditions and to identify how to best minimize impacts caused by recreation, actions that impact water quality, wildfire, predation, disease, and small population size. 1.1. Investigate sensitivity of environmental DNA (eDNA) techniques to assist with rangewide monitoring, detection of unidentified extant populations, and monitoring for Bd, particularly in areas considered for releases (Priority 3). 1.2. Conduct genetic analysis of frogs throughout the range to inform movement of individuals to augment or reestablish populations (Priority 2). 1.3. Research the historical impact of Bd and current potential treatments for southern Rana muscosa (Priority 1). 1.4. Investigate the cutaneous microbial community structure on wild and captive individuals. Evaluate utility of bioaugmentation as a potential tool to prevent infections on released individuals and to treat wild individuals (Priority 1). 1.5. Investigate potential impacts from contaminants, specifically considering chemicals used during fire suppression and for maintenance of cannabis plantations (Priority 3). 1.6. Investigate threats that may impact captive populations (Bd treatment and water quality) (Priority 1). 1.7. Conduct research to improve captive breeding success, including consideration of husbandry and behavioral training, and release strategies of captive-bred or translocated individuals (Priority 3). 1.8. Determine metrics for evaluating effectiveness of translocations (Priority 1). 1.9. Investigate overwintering habitat use (Priority 3). 1.10. Investigate the use of cameras and photo stations to improve detection and monitoring of frogs (Priority 3) (USFWS, 2018a).
- Southern DPS 2. Create and implement a protocol for rangewide surveys and monitoring. This protocol will allow for comparison of the relative status of the species within and between watersheds and would help in the development of a PVA. 2.1. Continue annual monitoring of extant populations (attempt three surveys at each extant population each year to standardize effort and provide greater confidence in trends in abundance and demography). After monitoring for 5 years, monitoring for effectiveness of releases and translocations should be incorporated into regular monitoring responsibilities. Collect and report data on threats during annual monitoring (Priority 2). 2.2. Prioritize and conduct surveys for unidentified populations based on information from previous survey efforts and the expertise of USGS, USFS, and CDFW biologists (particularly to identify trout-occupied waters and perennial waters) (Priority 3). 2.3. Develop a formal presence/absence survey

protocol to determine occupancy throughout the range (Priority 3). 2.4. Use data from monitoring and research to develop a Population Viability Analysis (PVA) for southern Rana muscosa in each management unit (MU). A PVA would help inform the implementation of other recovery actions and the assessment of recovery criteria. Include PVA with augmentation and without augmentation or removal of animals for translocation. 2.4.1. Develop a PVA for the San Gabriel MU (Priority 3). 2.4.2. Develop a PVA for the San Bernardino Mountains MU (Priority 3). 2.4.3. Develop a PVA for the San Jacinto Mountains/Palomar Mountain MU (Priority 3) (USFWS, 2018a).

- Southern DPS 3. Ameliorate Factor A threats associated with present or threatened destruction, modification, or curtailment of the habitat or range where appropriate throughout each of the three Management Units: 3.1. Address recreational impacts through continued monitoring at extant locations, use of closure orders, and public education. All, or a combination of, these actions are of particular importance at the Little Rock and Dark Canyon populations (Priority 2). 3.2. Test water quality near cannabis plantations or other occupied areas for potential detection of herbicides, pesticides, rodenticides, and fertilizers. Remove illegal plantations and associated infrastructure and restore substrate to natural conditions (Priority 3). 3.3. Increase communication between USFS, Caltrans, and other necessary parties to prevent future roadwork-related spills or other impacts into occupied and critical habitats. Install markers indicating sensitive habitat along all roads with the potential to impact extant populations or critical habitat and post maps of occupied and critical habitats in Caltrans work stations (Priority 2). 3.4. Develop and implement appropriate fuel reductions in watersheds with extant populations to reduce wildfire risk (For example, conduct thinning of dense stands) (Priority 3). 3.5. Reduce impacts related to wildfire suppression activities by avoiding certain activities to the extent feasible, including limiting use of fire retardants in proximity to occupied habitat and water drafting from occupied habitat (Priority 1). 3.6. Identify and pursue land acquisitions to ensure habitat is available for southern Rana muscosa recovery (Priority 3) (USFWS, 2018a).
- Southern DPS 4. Ameliorate Factor C threats associated with predation and disease where appropriate in each of the three Management Units: 4.1. Prioritize areas for nonnative predator removal according to southern Rana muscosa risk and areas needed to reestablish connectivity and maintain selfsustaining metapopulations. Some areas for potential nonnative predator removal may include Big Rock Creek, Little Rock Creek, and Tahquitz Canyon. Also, avoid trout stocking in such areas (Priority 1). 4.2. Implement nonnative predator removal where necessary to restore habitat or protect southern Rana muscosa (Priority 1). 4.3. Continue barrier construction and maintenance where feasible to expand nonnative predator removal efforts and monitor for effectiveness of barriers (Priority 1). 4.4. Based on results of Bd research (Recovery Activity 1.3), implement actions to better understand the current impacts to southern Rana muscosa from disease (Priority 1). 4.5. Based on information from Recovery Activity 4.4, develop and implement management that will minimize potential disease impacts (Priority 1) (USFWS, 2018a).
- Southern DPS 5. Ameliorate Factor E threats associated with other natural or manmade factors affecting the continued existence of southern Rana muscosa where appropriate in each of the three Management Units. 5.1. If a potential exposure to contaminants occurs (for example, through fire suppression or maintenance of cannabis plantations in occupied areas), test waterways for specific components of contaminants. Identify contingency plans for such exposures, including removal from the wild or translocation of exposed individuals, habitat restoration, or long-term monitoring of contamination (Priority 1). 5.2. Identify and manage potential risks associated with ultraviolet radiation, nitrogen deposition, and acid

precipitation (Priority 3). 5.3. Identify and manage potential risks associated with global climate change. 5.3.1. Monitor habitat variables (temperature, drought periods, and stream volume from snow-fed waters) and responses to changes in environmental conditions that may be attributed to global climate change (aerial deposition, endocrine disruption, range shift, reduction in prey base, and changes in overwintering and breeding phenology) (Priority 2). 5.3.2. Consider likelihood of future perennial water availability during reestablishment planning. Adaptively manage any threats that manifest as a result of global climate change, such as decreased water flows, or increased temperatures (Priority 2) (USFWS, 2018a).

- Southern DPS 6. Ameliorate Factor E threats associated with small population size. Use reestablishment and augmentation as tools to increase abundance and expand distribution in the wild at those locations determined to be appropriate. 6.1. Assess and select areas within the historical range for reestablishment or augmentation. To guide decision-making when choosing future receiver sites, incorporate the following information: extinction probabilities of populations at potential receiver sites, abundance and genetic representation of source and receiver populations, threats at each receiver site, abundance of each lifestage to be utilized for augmentation or reestablishment, reestablishment of metapopulation dynamics, and land management issues (Priority 1). 6.2. Based on genetic data of frogs in each mountain range, develop a genetic management plan to help conserve the genetic diversity of southern Rana muscosa in each management unit when conducting reestablishment or augmentation (Manage the captive animals to match the genetic diversity of the wild) (Priority 2). 6.3. Determine what triggers would require individuals to be bred from different mountain ranges in an attempt to preserve the genetic diversity (Priority 3). 6.4. Continue captive propagation efforts to provide animals for release to augment or reestablish populations where necessary throughout the range (Priority 1). 6.5. Reestablish or augment populations using captive-bred or translocated individuals. Use methods established in Recovery Activity 1.7. Captive-bred or translocated individuals should be used to: 6.5.1. Augment existing populations to prevent extinction, and increase abundance or genetic diversity (Priority 1). 6.5.2. Reestablish historically occupied areas to create connectivity between populations and reestablish metapopulation dynamics (Priority 1). 6.5.3. Investigate the use of isolated pools or ponds to help facilitate augmentation and reintroduction of frogs (Priority 1). 6.5.4. Determine ability of southern Rana muscosa to coexist with native fishes (Priority 2). 6.6. Based on work conducted in Recovery Activity 1.8, monitor the effectiveness of augmented and reestablished populations: 6.6.1. In augmented populations, mark released individuals to help monitor effectiveness of efforts. Monitor survivorship, breeding capacity, and movement of released animals (Priority 1). 6.6.2. In reestablished populations, conduct marking of translocated and captivebred individuals (for example, polymers or PIT tags) to track effectiveness of program. Monitor survivorship, breeding capacity, and movement of translocated individuals and individuals released from captivity (Priority 1). 6.7. Identify the density of southern Rana muscosa in streams to inform selection of future sites as reestablishment areas (Priority 2) (USWFS, 2018a).
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Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are to be initiated over the next 5 years to reduce threats to the mountain yellow legged frog. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid with future restoration efforts. 1. Continue population augmentation and reestablishment within the three mountain ranges with extant occurrences. 2. Continue research on Bd treatments to aid in reestablishment of mountain yellowlegged frogs. 3. Continue nonnative predator trout removal efforts where feasible to help expand suitable habitat. 4. Continue monitoring, including mark/recapture, to assess and track population sizes and trends. 5. Continue to minimize the potential effects of recreation (USFWS, 2024).

Additional Threshold Information:

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References

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See adult life stage.

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Legged Frog, and Threatened Status for the Yosemite Toad, Proposed Rule. Vol. 78, No. 80, Federal Register 24471. April 25, 2013.

U.S. Fish and Wildlife Service. 2018a. Recovery Implementation Strategy for the southern California distinct population segment of the mountain yellow-legged frog. U.S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, California. ii + 18 pp.

U.S. Fish and Wildlife Service. 2018b. Recovery Plan for the southern California distinct population segment of the mountain yellow-legged frog. U.S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, California. iv + 24 pp.

USFWS. 2024. 5-YEAR REVIEW Mountain Yellow-legged Frog [Southern California Distinct Population Segment (Rana muscosa)]. Carlsbad Fish and Wildlife Office Carlsbad, California. 17 pp.

SPECIES ACCOUNT: *Rana pretiosa* (Oregon spotted frog)

Species Taxonomic and Listing Information

Listing Status: Threatened; August 29, 2014 (79 FR 51658).

Physical Description

The Oregon spotted frog is a medium-sized frog that ranges from about 44 to 105 millimeters (mm) (1.7 to 4.1 inches [in.]) in body length. Females are typically larger than males; females reach up to 105 mm (4 in.) and males up to 75 mm (3 in.). The Oregon spotted frog has characteristic black spots covering the head, back, sides, and legs. The dark spots have ragged edges and light centers, usually associated with a tubercle (raised area of skin). The coloration patterns on Oregon spotted frogs all develop with age; the spots become larger and darker and the edges become more ragged as the individual ages. Overall body color also varies with age. Juveniles are usually brown or occasionally olive green on the back; and white, cream, or flesh-colored with reddish pigments on the underlegs and abdomen developing with age. Adults range from brown to reddish brown, but tend to become redder with age. Large, presumably older, individuals may be brick-red over most of the dorsal (back) surfaces. Red surface pigments on the adult abdomen also expand with age, and the underlegs of adults become a vivid red-orange. Tan to orange folds along the sides of the back (dorsolateral folds) extend from behind the eye to midway along the back. The eyes are upturned; there is a faint mask, and a light jaw stripe extends to the shoulder. Small bumps and tubercles usually cover the back and sides. The hind legs are short relative to body length, and the hind feet are fully webbed (79 FR 51658).

Taxonomy

The Oregon spotted frog can be differentiated from the closely related Columbia spotted frog (Rana luteiventris) by its mottling with dark pigments and fragmentation of the superficial red or orange-red wash on the abdomen. Other characteristics—such as coloration of the underlegs and abdomen; size and shapes of the spots; groin mottling; eye positions; degree of webbing; and behaviors—can be used to distinguish Oregon spotted frogs from adults of closely related species (79 FR 51658).

Historical Range

Historically, the Oregon spotted frog ranged from British Columbia to the Pit River basin in northeastern California (79 FR 51658).

Current Range

Currently, the Oregon spotted frog is found from extreme southwestern British Columbia, south through the Puget Trough; and in the Cascade Range from south-central Washington at least to the Klamath Basin in southern Oregon. In addition, Oregon spotted frogs currently have a very limited distribution west of the Cascade crest in Oregon, are considered to be extirpated from the Willamette Valley in Oregon, and may be extirpated from the Klamath and Pit River basins of California. It is estimated that the species no longer occurs in 76 to 90 percent of its historical range. (79 FR 51658). From Draft SBR (2021): Since being listed as threatened under the ESA, the Oregon spotted frog's range has not expanded or contracted, but new information within sub-basins across the range has become available. In Washington, new populations have been located in the Nooksack, Nisqually/Puget Sound Frontal, and Upper Chehalis sub-basins and new breeding sites have been discovered in the Straits of Georgia sub-basin. In Oregon, new breeding sites were located in the Upper Deschutes sub-basin, and a new population was discovered in the Williamson River sub-basin. The Oregon spotted frog no longer occurs in an estimated 76 to 90 percent of its historical range (USFWS 2014, p. 51663). Currently, Oregon spotted frogs are found within small portions of 16 sub-basins ranging from southwestern British Columbia south through the Puget Trough in Washington, and the Cascade Range from south-central Washington to the Klamath Basin in southern Oregon (79 FR 51662-51663, Table 1; USFWS 2024a, pp. 9-11). Of these 16 subbasins, 15 are located in the U.S. (USFWS, 2024)

Critical Habitat Designated

Yes; 6/10/2016.

Legal Description

On May 11, 2016, the U.S. Fish and Wildlife Service (Service), designated critical habitat for the Oregon spotted frog (Rana pretiosa) under the Endangered Species Act. In total, approximately 65,038 acres (26,320 hectares) and 20.3 river miles (32.7 river kilometers) in Whatcom, Skagit, Thurston, Skamania, and Klickitat Counties in Washington, and Wasco, Deschutes, Klamath, Lane, and Jackson Counties in Oregon, fall within the boundaries of the critical habitat designation.

Critical Habitat Designation

Fourteen units are designated as critical habitat for the Oregon spotted frog. Those 14 units are: (1) Lower Chilliwack River; (2) South Fork Nooksack River; (3) Samish River; (4) Black River; (5) White Salmon River; (6) Middle Klickitat River; (7) Lower Deschutes River; (8) Upper Deschutes River; (9) Little Deschutes River; (10) McKenzie River; (11) Middle Fork Willamette River; (12) Williamson River; (13) Upper Klamath Lake; and (14) Upper Klamath.

Critical Habitat Unit 1: Lower Chilliwack River The Lower Chilliwack River unit consists of 143 ac (58 ha) and 4.4 river mi (7 river km) in Whatcom County, Washington. This unit includes the Sumas River and adjacent seasonally wetted areas from approximately the intersection with Hopewell Road downstream to the confluence with Swift Creek. This unit also includes portions of an unnamed tributary just south of Swift Creek, along with the adjacent seasonally wetted areas. Critical habitat in the river segments is defined as the stream and the associated hydrologic floodplain. Oregon spotted frogs are known to currently occupy this unit (Bohannon et al. 2012). The entire area within this unit is under private ownership. All of the essential physical or biological features are found within the unit, but are impacted by invasive plants (reed canarygrass), woody vegetation plantings, and hydrologic modification of river flows. The essential features within this unit may require special management considerations or protection to ensure maintenance or improvement of the existing nonbreeding, breeding, rearing, and overwintering habitat, aquatic movement corridors, or refugia habitat, as well as to address any changes that could affect these features.

Critical Habitat Unit 2: South Fork Nooksack River The South Fork Nooksack River unit consists of 111 ac (45 ha) and 3.5 river mi (5.7 river km) in Whatcom County, Washington. This unit includes the Black Slough and adjacent seasonally wetted areas from the headwaters to the confluence with South Fork Nooksack River. This unit also includes wetlands and seasonally wetted areas along Tinling Creek and the unnamed tributary to the Black Slough. Critical habitat in the river segments is defined as the stream and the associated hydrologic floodplain. Oregon spotted frogs are known to currently occupy this unit (Bohannon et al. 2012; Danilson et al. 2013). The entire area within this unit is under private ownership, including one nonprofit conservation organization. All of the essential physical or biological features are found within the unit, but are impacted by invasive plants (reed canarygrass), woody vegetation plantings and succession, and beaver removal efforts. The essential features within this unit may require special management considerations or protection to ensure maintenance or improvement of the existing nonbreeding, breeding, rearing, and overwintering habitat, aquatic movement corridors, or refugia habitat, as well as to address any changes that could affect these features.

Critical Habitat Unit 3: Samish River The Samish River unit consists of 984 ac (398 ha) and 1.7 river mi (2.8 river km) in Whatcom and Skagit Counties, Washington. This unit includes the Samish River and adjacent seasonally wetted areas from the headwaters downstream to the confluence with Dry Creek. Critical habitat in the river segments is defined as the stream and the associated hydrologic floodplain. Oregon spotted frogs are known to currently occupy this unit (Bohannon et al. 2012; Danilson et al. 2013). Within this unit, currently less than 1 ac (less than 1 ha) is managed by WDNR, 7 ac (3 ha) is managed by Skagit County, and 976 ac (395 ha) and 2 river mi (3 river km) are privately owned, including three nonprofit conservation organizations. All of the essential physical or biological features are found within the unit, but are impacted by invasive plants (reed canarygrass), woody vegetation plantings and succession, and beaver removal efforts. The essential features within this unit may require special management considerations or protection to ensure maintenance or improvement of the existing nonbreeding, breeding, rearing, and overwintering habitat, aquatic movement corridors, or refugia habitat, as well as to address any changes that could affect these features.

Critical Habitat Unit 4: Black River The Black River unit consists of 4,880 ac (1,975 ha) and 7.5 river mi (12 river km) in Thurston County, Washington. This unit includes the Black River and adjacent seasonally wetted areas from Black Lake downstream to approximately 3 mi (5 km) south of the confluence with Mima Creek. This unit also includes six tributaries to the Black River (Dempsey Creek, Salmon Creek, Blooms Ditch, Allen Creek, Beaver Creek, and Mima Creek), one tributary to Black Lake (Fish Pond Creek), and their adjacent seasonally wetted areas. Critical habitat in the river segments is defined as the stream and the associated hydrologic floodplain. Oregon spotted frogs are known to currently occupy this unit (Hallock 2013; WDFW and USFWS multiple data sources). Within this unit, currently 877 ac (355 ha) are federally managed by the Nisqually NWR (873 ac (353 ha)) and the Department of Energy (4 ac (2 ha)); 375 ac (152 ha) are managed by State agencies, including the Washington Department of Fish and Wildlife and Department of Natural Resources; 485 ac (196 ha) are County managed; and 3,143 ac (1,272 ha) are privately owned, including three nonprofit conservation organizations. Within this unit, currently 5.9 river mi (9.49 river km) are privately owned; less than 1 river mi (less than 1 river km) is dually managed/owned (i.e., different owners on opposite sides of the river); and less than 1 river mi (less than 1 river km) each is managed by Nisqually NWR, State agencies, and Thurston County. All of the essential physical or biological features are found within the unit, but are impacted by invasive plants (reed canarygrass), woody vegetation plantings and succession, and beaver removal efforts. The essential features within this unit may require special management considerations or protection to ensure maintenance or improvement of the existing nonbreeding, breeding, rearing, and overwintering habitat, aquatic movement corridors, or refugia habitat, as well as to address any changes that could affect these features.

Critical Habitat Unit 5: White Salmon River The White Salmon River unit consists of 1,225 ac (496 ha) and 3.2 river mi (5.2 river km) in Skamania and Klickitat Counties, Washington. This unit includes the Trout Lake Creek from the confluence with Little Goose Creek downstream to the confluence with White Salmon River, Trout Lake, and the adjacent seasonally wetted areas. Critical habitat in the river segments is defined as the stream and the associated hydrologic floodplain. Oregon spotted frogs are known to currently occupy this unit (Hallock 2011 and Hallock 2012). Within this unit, currently 108 ac (44 ha) and 1 river mi (2 river km) are managed by the USFS Gifford-Pinchot National Forest, 1,084 ac (439 ha) are managed by WDNR as the Trout Lake NAP, and 33 ac (13 ha) and 2 river mi (4 river km) are privately owned. All of the essential physical or biological features are found within the unit, but are impacted by invasive plants and nonnative predaceous fish. The essential features within this unit may require special management considerations or protection to ensure maintenance or improvement of the existing nonbreeding, breeding, rearing, and overwintering habitat, aquatic movement corridors, or refugia habitat, as well as to address any changes that could affect these features.

Critical Habitat Unit 6: Middle Klickitat River The Middle Klickitat River unit consists of 4,220 ac (1,708 ha) in Klickitat County, Washington. This unit encompasses Conboy Lake, Camas Prairie, and all water bodies therein, and extends to the northeast along Outlet Creek to Mill Pond. The southwestern edge is approximately Laurel Road, the southern edge is approximately BZ Glenwood Highway, and the northern edge follows the edge of Camas Prairie to approximately Willard Spring. Oregon spotted frogs are known to currently occupy this unit (Hayes and Hicks 2011). Within this unit, currently 4,069 ac (1,647 ha) are managed by the Conboy Lake NWR, and 151 ac (61 ha) are privately owned. All of the essential physical or biological features are found within the unit, but are impacted by water management, exotic plant invasion, native tree encroachment, and nonnative predaceous fish and bullfrogs. The essential features within this unit may require special management considerations or protection to ensure maintenance or improvement of the existing nonbreeding, breeding, rearing, and overwintering habitat, aquatic movement corridors, or refugia habitat, as well as to address any changes that could affect these features. Within this unit, we are excluding lands managed under the Glenwood Valley Coordinated Resource Management Plan and Conservation Agreement.

Critical Habitat Unit 7: Lower Deschutes River The Lower Deschutes River unit consists of 90 ac (36 ha) in Wasco County, Oregon. This unit includes Camas Prairie and Camas Creek, a tributary to the White River, and occur entirely on the Mt. Hood National Forest. Oregon spotted frogs are known to currently occupy this unit (C. Corkran, pers. comm. October 2012). All of the essential physical or biological features are found within the unit but are impacted by vegetation succession (conifer encroachment). The essential features within this unit may require special management considerations or protection to ensure maintenance or improvement of the existing nonbreeding, breeding, rearing, and overwintering habitat, aquatic movement corridors, or refugia habitat, as well as to address any changes that could affect these features.

Critical Habitat Unit 8: Upper Deschutes River The Upper Deschutes River unit includes 24,032 ac (9,726 ha) in Deschutes and Klamath Counties, Oregon, in the Upper Deschutes River sub-basin. The Upper Deschutes River unit extends from headwater streams and wetlands draining to Crane Prairie and Wickiup Reservoirs to the Deschutes River downstream to Bend, Oregon. This unit also includes Odell Creek and Davis Lake. Within this unit, currently 23,213 ac (9,394 ha) are managed by the USFS Deschutes National Forest, 185 ac (75 ha) are managed by Oregon Parks and Recreation Department, 45 ac (18 ha) are owned by the counties, and 589 ac (238 ha) are privately owned. A subset of the acreage managed by the Deschutes National Forest occurs within Wickiup and Crane Prairie reservoirs, which are operated by the Bureau of Reclamation. The Upper Deschutes River unit consists of two subunits: Below Wickiup Dam (Subunit 8A) and Above Wickiup Dam (Subunit 8B). Oregon spotted frogs are known to currently occupy this unit (USGS 2006 and 2012 datasets; Sunriver Nature Center; and USFS multiple data sources). The essential features within this unit may require special management considerations or protection to ensure maintenance or improvement of the existing nonbreeding, breeding, rearing, and overwintering habitat, aquatic movement corridors, or refugia habitat, as well as to address any changes that could affect these features. Storage and release of water from the reservoir system influences the physical and biological features between the subunits. Within this unit, we are excluding lands managed under the Sunriver Great Meadow Management Plan, the Crosswater Environmental Plan, and the Old Mill Pond Oregon Spotted Frog Candidate Conservation Agreement with Assurances (CCAA). Subunit 8A: Below Wickiup Dam This subunit includes 2,001 ac (810 ha). This subunit consists of the Deschutes River and associated wetlands downstream of Wickiup Dam to Bend, Oregon, beginning at the outlet of an unnamed tributary draining Dilman Meadow. Within this subunit, currently 1,182 ac (479 ha) are managed by the USFS Deschutes National Forest, 185 ac (75 ha) are managed by Oregon Parks and Recreation Department, 45 ac (18 ha) are managed by Deschutes County, and 589 ac (238 ha) are privately owned. All of the essential physical or biological features are found within the subunit but are impacted by hydrologic modification of river flows, reed canarygrass, nonnative predaceous fish, and bullfrogs. The essential features within occupied habitat within this subunit may require special management considerations or protection to ensure maintenance or improvement of the existing nonbreeding, breeding, rearing, and overwintering habitat, aquatic movement corridors, or refugia habitat, as well as to address any changes that could affect these features. Subunit 8B: Above Wickiup Dam This subunit includes 22,031 ac (8,916 ha). This subunit includes the following lakes, including associated wetlands, in the upper watersheds that flow into the Crane Prairie/Wickiup Reservoir system: Hosmer Lake, Lava Lake, Little Lava Lake, Winopee Lake, Muskrat Lake, and Little Cultus Lake, Crane Prairie and Wickiup Reservoirs, and Davis Lake. The following riverine waterbodies and associated wetlands are critical habitat: Deschutes River from Lava Lake to Wickiup Reservoir, Cultus Creek downstream of Cultus Lake, Deer Creek downstream of Little Cultus Lake, and Odell Creek from an occupied unnamed tributary to the outlet in Davis Lake. The land within this subunit is primarily under USFS ownership. However, the Bureau of Reclamation manages the operation of Crane Prairie and Wickiup reservoirs. Within this subunit, currently 22,031 ac (8,916 ha) are managed by the USFS Deschutes National Forest and less than 1.0 ac (0.14 ha) is in private ownership. All of the essential physical or biological features are found within the subunit but are impacted by vegetation succession and nonnative predaceous fish. Physical and biological features found within the reservoirs in this unit are affected by the storage and release of water for irrigation. The essential features within this subunit may require special management considerations or protection to ensure maintenance or improvement of the existing nonbreeding, breeding, rearing, and overwintering habitat, aquatic movement corridors, or refugia habitat, as well as to address any changes that could affect these features.

Critical Habitat Unit 9: Little Deschutes River The Little Deschutes River unit consists of 11,033 ac (4,465 ha) in Klamath and Deschutes Counties, Oregon. The Little Deschutes River unit includes the extent of the Little Deschutes River and associated wetlands from the headwaters to the confluence with the Deschutes River, 1 mi (1.6 km) south of Sunriver and approximately 20 mi (32.2 km) south of Bend, Oregon. This unit includes the following tributaries, including adjacent wetlands: Big Marsh Creek, Crescent Creek, and Long Prairie Creek. Oregon spotted frogs are known to currently occupy this unit (USGS, Sunriver Nature Center, and USFS multiple data sources). Within this unit, currently 5,288 ac (2,140 ha) are managed by the USFS Deschutes National Forest and Prineville BLM, 14 ac (6 ha) are managed by the State of Oregon, 80 ac (32 ha) are managed by Deschutes and Klamath Counties, and 5,651 ac (2,287 ha) are privately owned. Additionally, the essential physical or biological features are found within the unit but are impacted by hydrologic manipulation of water levels for irrigation, nonnative predaceous fish, reed canarygrass, and bullfrogs. The essential features within occupied areas within this unit may require special management considerations or protection to ensure maintenance or improvement of the existing nonbreeding, breeding, rearing, and overwintering habitat, aquatic movement corridors, or refugia habitat, as well as to address any changes that could affect these features. Within this unit, we are excluding lands managed under the Crosswater Environmental Plan.

Critical Habitat Unit 10: McKenzie River Sub-Basin The McKenzie River unit consists of 98 ac (40 ha) in Lane County, Oregon. This critical habitat unit occurs in the Mink Lake Basin, located in the headwaters of the main South Fork of the McKenzie River on the McKenzie River Ranger District of the USFS Willamette National Forest. The McKenzie River unit includes seven wilderness lakes, marshes, and ponds: Penn Lake, Corner Lake, Boat Lake, Cabin Meadows, two unnamed marshes, and a pond northeast of Penn Lake. A small segment of the South Fork McKenzie River between the two unnamed marshes also is included within this critical habitat unit. The entire area within this unit is under USFS ownership. Oregon spotted frogs are known to currently occupy this unit (Adams et al. 2011). All of the essential physical or biological features are found within the unit, but are impacted by nonnative predaceous fish, isolation, and vegetation encroachment. The essential features within this unit may require special management considerations or protection to ensure maintenance or improvement of the existing nonbreeding, breeding, rearing, and overwintering habitat, aquatic movement corridors, or refugia habitat, as well as to address any changes that could affect these features.

Critical Habitat Unit 11: Middle Fork Willamette River The Middle Fork Willamette River unit consists of 292 ac (118 ha) in Lane County, Oregon. This unit includes Gold Lake and bog, which are located in the 465-ac (188-ha) Gold Lake Bog Research Natural Area on the upstream end of Gold Lake on the USFS Willamette National Forest. The entire area within this unit is under USFS ownership. Oregon spotted frogs are known to currently occupy this unit (USFS data sources). All of the essential physical or biological features are found within the unit, but are impacted by nonnative predaceous fish, isolation, and vegetation encroachment. The essential features within this unit may require special management considerations or protection to ensure maintenance or improvement of the existing nonbreeding, breeding, rearing, and overwintering habitat, aquatic movement corridors, or refugia habitat, as well as to address any changes that could affect these features.

Critical Habitat Unit 12: Williamson River The Williamson River unit consists of 15,331 ac (6,204 ha) in Klamath County, Oregon. This unit includes the Williamson River and adjacent, seasonally wetted areas in Klamath Marsh NWR 4.89 mi (7.87 km) east of Silver Lake Highway, north to 0.998 mi (1.61 km) southeast of Big Springs, north through the Refuge to 0.24 mi (0.36 km) southeast of Three Creek spring, and upstream to 2.14 mi (3.44 km) north of the confluence with Aspen Creek. This unit also includes a portion of one tributary to the Williamson River (Jack Creek) and its adjacent seasonally wetted areas from National Forest Road 94, south of National

Forest Road 88 through 1.32 mi (2.12 km) of O’Connor Meadow. Oregon spotted frogs are known to currently occupy this unit (USGS, USFS, and USFWS multiple data sources). Within this unit, 10,418 ac (4,216 ha) are federally managed by the Klamath Marsh NWR and the USFS Fremont-Winema National Forest, and 4,913 ac (1,988 ha) are privately owned. Additionally, the essential physical or biological features are found within the unit, but are impacted by invasive plants (reed canarygrass), woody vegetation succession, absence of beaver, and nonnative predators. The essential features within occupied areas within this unit may require special management considerations or protection to ensure maintenance or improvement of the existing nonbreeding, breeding, rearing, and overwintering habitat, aquatic movement corridors, or refugia habitat, as well as to address any changes that could affect these features.

Critical Habitat Unit 13: Upper Klamath Lake The Upper Klamath Lake unit consists of 2,337 ac (946 ha) in Klamath County, Oregon. This unit includes the Wood River and its adjacent seasonally wetted areas from its headwaters downstream to the BLM south levee road just north of the confluence with Agency Lake as well as the complete length of the Wood River Canal (west of the Wood River) and its adjacent seasonally wetted areas starting 1.80 mi (2.90 km) south of Weed Road and continuing south. This unit also includes two tributaries to the Wood River (Fort Creek and Annie Creek) and their adjacent seasonally wetted areas: Fort Creek in its entirety from its headwaters to the junction of the Wood River and Annie Creek 0.75 mi (1.2 km) downstream from the Annie Creek Sno-Park to its junction with the Wood River. In addition, this unit includes three creeks (Sevenmile, Crane, and Fourmile) that flow into Sevenmile Canal and then into Agency Lake and their adjacent seasonally wetted areas. Sevenmile Creek includes 1.40 mi (2.25 km) beginning north of Nicholson Road, south to the confluence of Crane Creek as well as the entire length of two connected tributaries (Blue Spring and Short Creek) and the associated, adjacent seasonally wetted areas. Crane Creek includes adjacent seasonally wetted areas 0.28 mi (0.44 km) from its headwaters south to the confluence with Sevenmile Creek as well as two tributaries (Mares Egg spring and a portion of an unnamed spring to the west of Crane Creek 0.16 mi (0.30 km) south of three unnamed springs near Sevenmile Road). Fourmile Creek includes the adjacent seasonally wetted areas associated with the historical Crane Creek channel, Threemile Creek, Cherry Creek, Jack springs, Fourmile springs, the confluence of Nannie Creek, and the north-south canals that connect Fourmile Creek to Crane Creek. Oregon spotted frogs are known to currently occupy this unit (BLM, USFS, USGS, and USFWS multiple data sources). Within this unit, 1,259 ac (510 ha) are managed by the BLM, USFS Fremont-Winema National Forest, and Bureau of Reclamation; 9 ac (4 ha) are managed by Oregon State Parks; less than 1 ac (

Critical Habitat Unit 14: Upper Klamath The Upper Klamath unit consists of 262 ac (106 ha) of lakes and creeks in Klamath and Jackson Counties, Oregon. In Klamath County, Buck Lake critical habitat includes seasonally wetted areas adjacent to the western edge of Buck Lake encompassing Spencer Creek downstream due west of Forest Service Road 46, three unnamed springs, and Tunnel Creek. Parsnip Lakes, in Jackson County, includes seasonally wetted areas associated with Keene Creek from the Keene Creek dam to 0.55 mi (0.88 km) east from the confluence of Mill Creek as well as four lakes associated with the creek. Oregon spotted frogs are known to currently occupy this unit (BLM, USFS, USGS, and USFWS multiple data sources). Within this unit, 103 ac (42 ha) are managed by the BLM and USFS Fremont-Winema National Forest, and 159 ac (64 ha) are privately owned. All of the essential physical or biological features are found within the unit, but are impacted by woody vegetation succession, nonnative predators, lack of beaver, and hydrological changes. The essential features within this unit may require special management considerations or protection to ensure maintenance or improvement of the existing nonbreeding, breeding, rearing, and overwintering habitat, aquatic movement corridors, or refugia habitat, as well as to address any changes that could affect these features.

Primary Constituent Elements/Physical or Biological Features

Critical habitat units are designated for Klickitat, Skagit, Skamania, Thurston, and Whatcom Counties in Washington and Deschutes, Jackson, Klamath, Lane, and Wasco Counties in Oregon. Within these areas, the PCEs of the physical or biological features essential to the conservation of the Oregon spotted frog consist of three components:

(i) Primary constituent element 1.— Nonbreeding (N), Breeding (B), Rearing (R), and Overwintering (O) Habitat. Ephemeral or permanent bodies of fresh water, including, but not limited to, natural or manmade ponds, springs, lakes, slow-moving streams, or pools within or oxbows adjacent to streams, canals, and ditches, that have one or more of the following characteristics: (A) Inundated for a minimum of 4 months per year (B, R) (timing varies by elevation but may begin as early as February and last as long as September); (B) Inundated from October through March (O); (C) If ephemeral, areas are hydrologically connected by surface water flow to a permanent water body (e.g., pools, springs, ponds, lakes, streams, canals, or ditches) (B, R); (D) Shallow-water areas (less than or equal to 12 inches (30 centimeters), or water of this depth over vegetation in deeper water (B, R); (E) Total surface area with less than 50 percent vegetative cover (N); (F) Gradual topographic gradient (less than 3 percent slope) from shallow water toward deeper, permanent water (B, R); (G) Herbaceous wetland vegetation (i.e., emergent, submergent, and floating-leaved aquatic plants), or vegetation that can structurally mimic emergent wetland vegetation through manipulation (B, R); (H) Shallow-water areas with high solar exposure or low (short) canopy cover (B, R); and (I) An absence or low density of nonnative predators (B, R, N).

(ii) Primary constituent element 2.— Aquatic movement corridors. Ephemeral or permanent bodies of fresh water that have one or more of the following characteristics: (A) Less than or equal to 3.1 miles (5 kilometers) linear distance from breeding areas; and (B) Impediment free (including, but not limited to, hard barriers such as dams, impassable culverts, lack of water, or biological barriers such as abundant predators, or lack of refugia from predators).

(iii) Primary constituent element 3.— Refugia habitat. Nonbreeding, breeding, rearing, or overwintering habitat or aquatic movement corridors with habitat characteristics (e.g., dense vegetation and/or an abundance of woody debris) that provide refugia from predators (e.g., nonnative fish or bullfrogs).

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 June 10, 2016.

Threats to the physical or biological features that are essential to the conservation of this species and that may warrant special management considerations or protection include, but are not limited to: (1) Habitat modifications brought on by nonnative plant invasions or native vegetation encroachment (trees and shrubs); (2) loss of habitat from conversion to other uses; (3) hydrologic manipulation; (4) removal of beavers and features created by beavers; (5) livestock grazing; and

(6) predation by invasive fish and bullfrogs. These threats also have the potential to affect the PCEs if conducted within or adjacent to designated units.

The physical or biological features essential to the conservation of the Oregon spotted frog may require special management considerations or protection to ensure the provision of wetland conditions and landscape context of sufficient quantity and quality for long-term conservation and recovery of the species. Management activities that could ameliorate the threats described above include (but are not limited to): Treatment or removal of exotic and encroaching vegetation (for example mowing, burning, grazing, herbicide treatment, shrub/tree removal); modifications to fish stocking and beaver removal practices in specific water bodies; nonnative predator control; stabilization of extreme water level fluctuations; restoration of habitat features; and implementation of appropriate livestock grazing practices.

Life History

Food/Nutrient Resources

Food Source

Larvae: Plant tissue, bacteria, algae, detritus, and carrion (79 FR 51658).

Juvenile: Insects and vertebrates. From draft SBR: Post-metamorphic Oregon spotted frogs feed on live animals, primarily insects and spiders, but occasionally small vertebrates such as fish and other amphibians, including conspecifics (Licht 1986, pp. 27-28; Pearl and Hayes 2002, p. 145; Waddell 2015 pp. 109-110; Wolf et al. 2019, p. 163; Rombough, 2019, p. 550).

Adult: Insects and vertebrates.

Food/Nutrient Narrative

Larvae: Oregon spotted frog tadpoles are opportunistic omnivores with rough tooth rows for scraping plant surfaces to feed on plant tissue, bacteria, algae, detritus, and carrion.

Juvenile: See Adult narrative.

Adult: Oregon spotted frog tadpoles are opportunistic omnivores with rough tooth rows for scraping plant surfaces to feed on plant tissue, bacteria, algae, detritus, and carrion. Juvenile and adult Oregon spotted frogs feed on insects, specifically leaf beetles (Chrysomelidae), ground beetles (Carabidae), spiders (Arachnida), rove beetles (Staphylinidae), syrphid flies (Syrphidae), long-legged flies (Dolichopodidae), ants (Formicidae), water striders (Gerridae), spittlebugs (Cercopidae), leaf hoppers (Cicadellidae), aphids (Aphididae), dragonflies and damsel flies (Odonates), and yellowjackets (Vespidae). They also feed on vertebrates, including adult Pacific tree frogs (Pseudacris regilla), small northern red-legged frogs (Rana aurora), and newly metamorphosed red-legged frogs and western toad juveniles (Anaxyrus boreas) (79 FR 51658).

Reproductive Strategy

Adult: R-selection, oviparity.

Lifespan

Egg: Eggs take 1-3 weeks to hatch.

Adult: Longevity of the species is not well understood. Most male Oregon spotted frogs probably only survive to 2 to 3 years of age. However, there are multiple examples of Oregon spotted frogs living beyond 7 years of age (79 FR 51658; USFWS 2011).

Breeding Season

Adult: Breeding occurs in February or March at lower elevations, and between early April and early June at higher elevations (79 FR 51658). Male Oregon spotted frogs are not territorial and often gather in large groups (25 or more individuals) at specific locations (Leonard et al. 1993, p. 132).

Key Resources Needed for Breeding

Egg: Eggs are laid in shallow (generally no more than 35 centimeters [cm] [14 in.] deep), often temporary, pools of water; on gradually receding shorelines; on benches of seasonal lakes and marshes; and in wet meadows. Shallow water is easily warmed by the sun, hastening egg development (79 FR 51658). Eggs can hatch in as few as 14 days (McAllister and Leonard 1997).

Other Reproductive Information

Larvae: Tadpoles metamorphose into froglets (about 16 to 43 mm [0.6 to 1.75 in.]) during their first summer (79 FR 51658).

Juvenile: Tadpoles metamorphose into froglets (about 16 to 43 mm [0.6 to 1.75 in.]) during their first summer (79 FR 51658).

Adult: Cases have been documented of males calling from submerged sites that are tens to hundreds of m (tens to thousands of ft.) from oviposition (egg-laying) sites, beginning several days before breeding. Females may deposit their egg masses at the same locations in successive years. Although egg masses are occasionally laid singly, the majority of egg masses are laid communally in groups of a few to several hundred (79 FR 51658).

Reproduction Narrative

Egg: See Adult narrative.

Larvae: See Adult narrative.

Juvenile: See Adult narrative.

Adult: Oregon spotted frog breeding occurs in February or March at lower elevations, and between early April and early June at higher elevations. Cases have been documented of males calling from submerged sites that are tens to hundreds of m (tens to thousands of ft.) from oviposition (egg-laying) sites, beginning several days before breeding. Females lay one egg mass per year, containing approximately 600 to 650 eggs, in shallow (less than 35 cm [14 in.] deep), often temporary, pools of water on gradually receding shorelines; on benches of seasonal lakes and marshes; and in wet meadows (USFWS 2011). Females often deposit egg masses at the same locations in successive years, and egg masses are often laid communally in groups of a few to several hundred. The shallow water is easily warmed by the sun, hastening egg development, but the eggs' placement in shallow water also leaves them vulnerable to desiccation and freezing, and egg mortality is estimated to be 30 percent (79 FR 51658; USFWS 2011). Eggs can hatch in as few as 14 days if exposed to warm temperatures, but 18 to 30 days is likely a more typical period for development to hatching (McAllister and Leonard 1997).Males and females separate soon after egg-laying, and there is no parental care of eggs or tadpoles. The heaviest losses to predation are thought to occur shortly after tadpoles emerge from eggs (mortality rates are approximately 99 percent), when they are poor swimmers and relatively exposed. However, the odds of survival appear to increase as tadpoles grow in size. Tadpoles may be preyed on by numerous vertebrate predators, including several species of birds, snakes, amphibians, and fish. Tadpoles metamorphose into froglets (about 16 to 43 mm [0.6 to 1.75 in.]) during their first summer, and mortality rates of froglets are approximately 95 percent (USFWS 2011). Oregon spotted frogs begin to breed by 1 to 3 years of age, depending on sex, elevation, and latitude (79 FR 51658).Adult Oregon spotted frogs have a number of documented and potential natural predators, including garter snakes (Thamnophis spp.) and several species of birds and mammals. Longevity of the species is not well understood, but adult mortality was estimated to be 36 percent over a 2-year study (USFWS 2011). Most males likely only survive 2 to 3 years; however, there are multiple examples of Oregon spotted frogs living beyond 7 years of age (79 FR 51658; USFWS 2011).

Habitat Type

Egg: Emergent wetlands in forested landscapes (79 FR 51658).

Larvae: Emergent wetlands in forested landscapes (79 FR 51658).

Juvenile: Emergent wetlands in forested landscapes (79 FR 51658).

Adult: Emergent wetlands in forested landscapes (79 FR 51658).

Habitat Vegetation or Surface Water Classification

Egg: Wetland

Larvae: Wetland

Juvenile: Wetland

Adult: Wetland

Dependencies on Specific Environmental Elements

Egg: Egg survival depends on shallow water areas (79 FR 51658).

Larvae: Tadpole survival depends on shallow water areas. Juveniles depend on perennially deep, moderately vegetated pools in the dry season. (79 FR 51658)

Juvenile: Juveniles depend on perennially deep, moderately vegetated pools in the dry season. (79 FR 51658)

Adult: Adults depend on perennially deep, moderately vegetated pools in the dry season (79 FR 51658).

Geographic or Habitat Restraints or Barriers

Larvae: Oregon spotted frogs are highly aquatic; therefore, their movement is limited to areas with sufficient emergent wetland habitat.

Juvenile: Oregon spotted frogs are highly aquatic; therefore, their movement is limited to areas with sufficient emergent wetland habitat.

Adult: Oregon spotted frogs are highly aquatic; therefore, their movement is limited to areas with sufficient emergent wetland habitat.

Spatial Arrangements of the Population

Egg: Clumped

Larvae: Random

Juvenile: Random

Adult: Varies; male Oregon spotted frogs are not territorial and often gather in large groups of 25 or more individuals at specific locations, while females are more solitary (79 FR 51658).

Environmental Specificity

Egg: Eggs are laid in shallow water.Females often select open areas of edges of ponds or lakes in which the water is heated by solar radiation to temperatures above 13° C (54° F) (Morris and Tanner 1969). Oviposition (egg laying) locations are in shallow, often seasonally flooded, pools of water; gradually receding shorelines; on benches of seasonal lakes and marshes; and in wet meadows. Egg laying locations are usually associated with the previous year's emergent vegetation and the water depths are generally no more than 35 centimeters (cm) (14 inches) deep (Pearl and Hayes 2004, pp. 19-20).

Larvae: Generalist

Juvenile: Generalist

Adult: Generalist

Tolerance Ranges/Thresholds

Larvae: Moderate - Amphibians have species- specific temperature tolerances, and exceeding these thermal thresholds is expected to reduce survival (Blaustein et al. 2010, pp. 286–287). The minimum amount of habitat thought to be required to maintain an Oregon spotted frog population is about 10 ac (4 ha) (Hayes 1994, Part II pp. 5 and 7).

Juvenile: Moderate - Amphibians have species- specific temperature tolerances, and exceeding these thermal thresholds is expected to reduce survival (Blaustein et al. 2010, pp. 286–287). The minimum amount of habitat thought to be required to maintain an Oregon spotted frog population is about 10 ac (4 ha) (Hayes 1994, Part II pp. 5 and 7). A highly aquatic species, it's never found far from various aquatic habitats, springs, small cold streams and lakes

Adult: Moderate- Amphibians have species- specific temperature tolerances, and exceeding these thermal thresholds is expected to reduce survival (Blaustein et al. 2010, pp. 286–287).

The minimum amount of habitat thought to be required to maintain an Oregon spotted frog population is about 10 ac (4 ha) (Hayes 1994, Part II pp. 5 and 7). A highly aquatic species, it's never found far from various aquatic habitats, springs, small cold streams and lakes

Site Fidelity

Egg: High

Larvae: High

Juvenile: High

Adult: High

Habitat Narrative

Egg: See Adult narrative.

Larvae: See Adult narrative.

Juvenile: See Adult narrative.

Adult: The Oregon spotted frog inhabits emergent wetlands in forested landscapes, and is the most aquatic native frog species in the Pacific Northwest. Individuals have been found at elevations ranging from near sea level in the Puget Trough lowlands in Washington, to approximately 1,500 m (5,000 ft.) in the Oregon Cascades in western Oregon. Egg and tadpole survival depends on shallow water areas. Adults and juveniles depend on perennially deep, moderately vegetated pools in the dry season and overwintering sites associated with flowing systems, such as springs and creeks, that provide well-oxygenated water and sheltering locations. Adults and juveniles burrow in mud, silty substrate, vegetation, and holes in creek banks during periods of prolonged or severe cold. Adult males are not territorial and often gather in large groups of 25 or more individuals, while females tend to be more solitary. Eggs are laid in shallow water, and tadpoles tend to remain in shallow water areas. (79 FR 51658)Because Oregon spotted frogs are highly aquatic, their dispersal is limited to areas with sufficient aquatic habitat. Habitat degradation due to dam construction, flood control measures, introduction of nonnative species, livestock grazing, and development threaten the ecological integrity of Oregon spotted frogs' habitat and community (79 FR 51658).

Dispersal/Migration

Motility/Mobility

Egg: None

Larvae: Moderate

Juvenile: Moderate

Adult: Moderate

Dispersal

Larvae: Low

Juvenile: Low

Adult: Low

Dispersal/Migration Narrative

Egg: See Adult narrative.

Larvae: See Adult narrative.

Juvenile: See Adult narrative.

Adult: Oregon spotted frogs are nonmigratory; they have relatively short dispersal distances and seasonal movements due to their highly aquatic nature. Adult frogs make infrequent movements between widely separated pools and more frequent movements between pools in closer proximity. Home ranges average 2.2 hectares (5.4 acres), and daily movement averages 5 to 7 m (16 to 23 ft.). During the breeding season (February to May), frogs use about half the area used during the rest of the year. During the dry season (June to August), frogs move to deeper, permanent pools and occupy the smallest range of any season. Adults often move less than 100 m (300 ft.) between years, but some individuals travel up to 2.3 kilometers (1.5 miles) between seasons (79 FR 51658).

Additional Life History Information

Juvenile: Movement studies suggest the species is limited in its overland dispersal and potential to recolonize more distant or isolated sites. Oregon spotted frog movements are associated with aquatic connections (Watson et al. 2003, p. 295; Pearl and Hayes 2004, p. 15). Oregon spotted frogs rely on aquatic connections within breeding sites as well as between breeding sites and active season and overwintering habitats to maintain population viability.

Adult: Movement studies suggest the species is limited in its overland dispersal and potential to recolonize more distant or isolated sites. Oregon spotted frog movements are associated with aquatic connections (Watson et al. 2003, p. 295; Pearl and Hayes 2004, p. 15). Oregon spotted frogs rely on aquatic connections within breeding sites as well as between breeding sites and active season and overwintering habitats to maintain population viability.

Population Information and Trends

Population Trends:

Declining (NatureServe 2015)

Species Trends:

Consistent declines of historically large populations have occurred since the Listing Rule (2016), increasing the risk of local extirpation and, ultimately, loss of viability.

Resiliency:

Overall, the Oregon spotted frog is estimated to have a moderate level of resiliency ranHigh or moderate levels of resiliency are present in 8 out of 16 (50 percent) of the remaining occupied sub-basins throughout the current species range. gewide.

Representation:

Present. To assess ecological representation, we looked at the resiliency of Oregon spotted frog populations within sub-basins within currently occupied ecoregions across the species' range. Our evaluation of Oregon spotted frog representation in the five ecoregions within the species' range determined that the species has a moderate or high resiliency within at least one sub-basin within four of the five ecoregions. Unfortunately, Oregon spotted frogs within the majority of sub-basins in the Klamath-Basin and West Cascades ecoregions have low levels of resiliency and are most likely to be threatened by catastrophic events such as prolonged drought or extreme flood events. The lower resiliency within these ecoregions places the Oregon spotted frog at greater risk for a reduction of representation (ecological and genetic diversity). There are six extant genetic groupings delineated across the range of the Oregon spotted frog: British Columbia, Chehalis drainage, Columbia drainage, Camas Prairie, Central Cascades, and Klamath Basin. At least one sub-basin with a moderate or high resiliency rank is present in five of the six delineated genetic groupings and the unknown genetic grouping across the range of the species. Of the six delineated genetic groupings, Camas Prairie within the Lower Deschutes River sub-basin, is at risk to loss of representation. The six delineated genetic groups and the unknown grouping are geographically isolated and occupy different habitat types, providing the Oregon spotted frog with the ability to adapt to changing environmental conditions through genetic diversity.

Redundancy:

Present. We evaluated redundancy by assessing the number and distribution of sub-basins where Oregon spotted frogs have moderate to high levels of resiliency in each of the five ecoregions where the species occurs. Oregon spotted frogs currently occur in 16 sub-basins in Washington, Oregon and British Columbia, Canada within five ecoregions. Distribution of the species spans nearly 500 miles or 7 degrees of latitude (42°N to 49°N). Redundancy is present within the range of the Oregon spotted frog. Our assessment found at least one sub-basin with moderate or high levels of resiliency within four of the five ecoregions. However, sub-basins with moderate to high levels of resiliency are not well-distributed in ecoregions throughout the range. We found that Oregon spotted frogs have lower levels of resiliency in a greater proportion of sub-basins within two ecoregions: West Cascades and East-Cascades-Klamath-Basin.

Population Growth Rate:

Declining

Number of Populations:

22 (NatureServe 2015)

Population Size:

The total adult population size is not precisely known, but it clearly exceeds 10,000 individuals; there was an approximate minimum of 20,000 individuals as of 2012 (NatureServe 2015). Number of reproductive individuals accounted for in the ESA listing (2014) = 21,573. Minimum estimate of reproductive adults in 2018-2020*= 14,494. *Not all sites surveyed annually so most recent numbers come from 2018, 2019, or 2020 depending on the location and most recent survey.

Minimum Viable Population Size:

Unknown. From SBR (2021): "Recovery goals for the Oregon spotted frog have been established in British Columbia as the following: (1) Establish or maintain 10 populations over the next 10 years, and (2) Each population will support a minimum number of breeding adults at each location needed to sustain viable populations. Until more specific information is available, the population objective is 200 breeding adults per location (Environment Canada 2015, pp. 28-29)." From Listing Rule (2016): " The Service does not consider the minimum population estimates in the Upper Deschutes River or Little Deschutes River sub-basins to constitute a population of ‘‘considerable size and viability.’’ Franklin (1980) proposed the 50/500 rule, whereby an effective population size (Ne) of 50 is required to prevent unacceptable rates of inbreeding and an Ne of 500 is required to ensure overall genetic variability. Phillipsen et al. (2010) compared the adult Oregon spotted frog census population (N = 428) from a breeding site near Sunriver, Oregon, to the effective population size (Ne = 36.7) with the result of Ne/N = 0.086, which fell within the general range of DNA- based estimates for ranid frogs (Phillipsen et al. 2010, p. 742). Application of the 50/500 rule provides that an Oregon spotted frog population of greater than 581 breeding adults (N/Ne = 50/.086) at the Sunriver breeding site would be required to prevent inbreeding depression and a population of 5,814 breeding adults (N/ Ne = 500/.086) would be required for a high probability of survival over time. Thus, the minimum population estimate for the Upper Deschutes River sub-basin (3,530) is considerably less than the population needed for only one site, Sunriver (5,814). "

Resistance to Disease:

Low. Bd (Chytrid Fungus)- Moderate resistence to chytrid (Pearl et al, 2009). "Bd was found in all sites surveyed (36 out of 36)....We rarely detected Bd in R. pretiosa larvae (2 of 72). Prevalence of Bd in postmetamorphic R. pretiosa was inversely related to frog size. We found support for an interactive effect of elevation and sampling date on Bd: prevalence of Bd generally increased with date, but this effect was more pronounced at lower elevations. We also found evidence that the body condition of juvenile R. pretiosa with Bd decreased after their first winter. Our data indicate that some Oregon spotted frog populations are currently persisting with relatively high Bd prevalence, but the risk posed by Bd is unknown."

Adaptability:

Representation in the Oregon spotted frog is about the ability to adapt to changing environmental conditions by having ecological and genetic diversity.. Oregon spotted frogs have moderate to high levels of resiliency in each of the five ecoregions where the species occurs and in five of the size delineated genetic groupings. Consequently, Oregon spotted frogs likely have the ability to adapt to environmental change if current declines throghout the range are reversed and this genetic and ecological diversity is maintained.

Population Narrative:

The Oregon spotted frog is declining in both abundance and distribution. Of 61 known historical localities, only 13 were occupied during studies conducted in the 1990s (79 FR 51658). As of 2012, there were 22 populations: four populations in British Columbia, six in Washington, and about 12 in Oregon. There we no populations in California, although not all potential habitat in California had been adequately surveyed. Over the past decade, abundance has declined approximately 10 to 30 percent, and most remaining populations are small and isolated. The total adult population size is not precisely known, but was estimated to be at least 20,000 adults as of 2012 (NatureServe 2015). For the species to be viable, the Oregon spotted frog requires multiple connected, resilient populations distributed in various ecoregions and genetic groupings, and large areas of protected and/or managed suitable aquatic habitat within each currently occupied hydrologic sub-basin. In this Species Report, viability of the Oregon spotted frog was assessed using the 3Rs (Resiliency, Redundancy, and Representation). Resiliency of populations was evaluated at the sub-basin scale. Populations or breeding sites were reviewed within each extant sub-basin in British Columbia (Canada), Washington, and Oregon using knowledge and expertise of biologists, including Service staff, and additional occurrence and population information obtained since the Listing Rule. We found that Oregon spotted frog were resilient within 50 percent of occupied sub-basins across the range. Redundancy and representation are present within the range. Sub-basins exhibiting resilient Oregon spotted frog populations occur in four of five currently occupied ecoregions (Puget Trough, East Cascades Mid-Columbia, East Cascades – Klamath Basin, and East Cascades – Deschutes Basin) and in five out of the six delineated genetic groupings (British Columbia, Chehalis Drainage, Columbia Drainage, Central Cascades, and Klamath Basin). After analyzing the 3Rs, we have determined that this species currently has moderate viability, meaning it has a moderate chance of maintaining populations in the wild over time. Consistent declines of historically large populations have occurred since the Listing Rule, increasing the risk of local extirpation and, ultimately, loss of viability. Both representation and redundancy across the species range are consequently at risk of reduction in the near future. In order to secure species viability, recovery actions should focus on expanding and enhancing aquatic habitat and hydrological function, increasing connectivity between populations to increase gene flow and recolonization following stochastic or catastrophic events, and removing or managing habitat threats such as non-native, predatory species, and invasive vegetation.

Threats and Stressors

Stressor: Competition and/or predation by nonnative species; Disease
Exposure: Nonnative predators- bullfrogs, crayfish, green frogs, warm-water fish, cold-water fish, trematodes (Ribeiroia ondatrae), Oomycete fungi, Saprolegnia spp., Chytrid fungus .
Response: Mortality due to predation, competition, disease.
Consequence: Declining populations of Oregon spotted frog.
Narrative: The introduction of nonnative species into the historical range of the Oregon spotted frog is believed to have contributed to the decline of the species. American bullfrogs (Lithobates catesbeianus) are known predators, and introduced fish such as brook trout (Salvelinus fontinalis) and centrarchids (Micropterus and Lepomis spp.) are also likely predators (79 FR 51658).

Stressor: Habitat modification and loss of connectivity
Exposure: Human activity such as dam construction, beaver removal, flood control measures, introduction of nonnative species, invasive vegetation (reed canary grass, woody shrubs and trees), mismanaged livestock grazing, and development.
Response: Declining habitat availability and loss of connectivity through: vegetation removal and/or alteration; hydrological alterations (changes to flow rates, drainage or flooding of wetlands, change in seasonality of inundation), new and existing residential and road developments, drought, and removal of beavers; livestock grazing and subsequent increased sedimentation. .

Consequence: Declining populations of Oregon spotted frog.
Narrative: Threats to the species' habitat include changes in hydrology due to construction of dams; and human-related alterations to seasonal flooding, introduction of nonnative plant and animal species, vegetation succession and encroachment, poor water quality, livestock grazing (in some circumstances), and residential and commercial development. Habitat losses and alterations affect amphibian species in a variety of ways, including reducing or eliminating immigration through losses of adjacent populations, and effects on critical aspects of the habitat. These critical aspects include suitable egg-laying and nursery sites, refuges from predation or unfavorable environmental conditions, and suitable temperatures necessary for egg laying, growth, and development (79 FR 51658).

Stressor: Small populations
Exposure: Small numbers of individuals.
Response: Increased risk of inbreeding and extirpation due to stochastic events.
Consequence: Lower genetic diversity and increased risk of extirpation.
Narrative: Small, isolated populations are more likely to be extirpated by stochastic events and genetic drift. Many of the Oregon spotted frog breeding locations comprise fewer than 50 adult frogs; are isolated from other breeding locations; and may already be stressed by other factors such as drought or predation, making them more vulnerable to random, naturally occurring events. Where Oregon spotted frog locations have small population sizes that are isolated, their vulnerability to extirpation from factors such as fluctuating water levels, disease, and predation increases (79 FR 51658).

Stressor: Climate change
Exposure: Changes in precipitation patterns due to climate change.
Response: Changes in amphibian ranges, breeding success, survival, dispersal, breeding phenology, habitat quality, food webs, competition, and disease.
Consequence: Declining populations of Oregon spotted frog.
Narrative: Short- and long-term changes in precipitation patterns and temperature regimes will likely affect wet periods, winter snow pack, and flooding events. These changes are likely to affect amphibians through a variety of direct and indirect pathways, such as range shifts, breeding success, survival, dispersal, breeding phenology, availability and quality of aquatic habitats, food webs, competition, spread of diseases, and the interplay among these factors (79 FR 51658).

Stressor: Chytrid fungus
Exposure: Infection by Batrachochytrium dendrobatidis (Bd).
Response: Mortality of individuals, potential for rapid extirpation of populations.
Consequence: Decline in the number of populations and abundance of the species as a whole.
Narrative: Bd has been implicated in the decline and extinction of numerous amphibian species in multiple locations around the world. Bd infection has been documented in at least seven ranid frog species from the Pacific Northwest, including Oregon spotted frogs. Infection by Bd can cause lethargy, abnormal posture, loss of righting reflex, and death. Mortality is caused by Bd interfering with skin functions, including maintaining fluid and electrolyte homeostasis, respiration, and the skin's role as a barrier to toxic and infectious agents. In 2007 and 2008, the U.S. Geological Survey sampled Oregon spotted frogs at sites across Washington and Oregon. Bd was confirmed at all locations sampled; however, morbidity or mortality attributable to Bd was not observed. Bd poses a risk to individual Oregon spotted frog populations, but additional

studies are needed to determine whether Bd is a threat range-wide to the Oregon spotted frog.

Recovery

Reclassification Criteria:
Recovery Priority Number: 8

Delisting Criteria:
Criterion 1: Oregon spotted frog populations are maintained or improved to a moderate or higher level of resiliency within a minimum of 12 sub-basins for at least 10 out of 15 years. Metrics used to determine resiliency thresholds for each sub-basin include (1) aquatic habitat acreage, hydroperiod, and connectivity; (2) spatial distribution of the species in suitable habitat; and (3) population abundance metrics and trends. (USFWS, 2024)

Criterion 2: The sub-basins with moderate or higher levels of resiliency used to satisfy Criterion 1 represent all six of the currently known genetic groups and at least two sub-basins represent each of the five ecoregional areas. (USFWS, 2024)

Criterion 3: Habitat is conserved and threats are managed with long-term conservation commitments to support sustained resiliency of Oregon spotted frog populations within the sub-basins used to satisfy Criterion 1. (USFWS, 2024)

Recovery Actions:
- 1. Restore and enhance wetland, riverine, and other aquatic habitats to support all life stages of the Oregon spotted frog. (USFWS, 2024)
- 2. Ameliorate threats from predation and disease to improve resiliency (USFWS, 2024)
- 3. Increase population size and reduce isolation of Oregon spotted frog populations within sub-basins to improve resiliency and representation (USFWS, 2024)
- 4. Promote awareness and increase conservation partnerships within the Oregon spotted frog range (USFWS, 2024)
- 5. Utilize regulation and policy tools to protect wetland habitat and promote water availability to support species recovery (USFWS, 2024)
- 6. Conduct inventory, monitoring, and research to guide and support Oregon spotted frog recovery (USFWS, 2024)

Conservation Measures and Best Management Practices:
- Chemical Use Conservation Measures The following measures are part of the proposed action and will be implemented to reduce unintentional adverse effects on listed species and their habitats, as well as other native species. Although no-spray buffers can reduce the potential for the chemicals to reach streams from overland flows that might otherwise carry herbicides directly to a stream, there is no general rule to determine appropriate buffer widths. The buffer distances in Table 6 are based on the presumption that pesticides and fertilizers applied near water can more readily reach water than chemicals that are applied well away from the water, but the specific distance is based on practical weed and insect control considerations, and is not derived from scientifically-based calculations.
- General: 1. Chemical usage will comply with all applicable Federal and State regulations pertaining to pesticide use, safety, storage, disposal, and reporting. 2. Applicators will only treat the

minimum area necessary to meet site objectives using the lowest effective label rates. 3. No pesticide treatment may be used within 25 ft of any listed, proposed, or candidate species individual. 4. All herbicide applications will occur when plant phenology is appropriate for the most efficient chemical uptake by the target species. 5. No aquatic application of any herbicides will occur in habitat occupied by listed fish species and/or is designated as critical habitat for listed fish species. 6. Post-treatment effectiveness monitoring will occur during and after treatment to determine whether invasive plants are being effectively controlled, and to ensure non-target vegetation is adequately protected. 7. Where feasible, mechanical, biological, or cultural pest management measures will be used in place of, or in conjunction with, herbicides to reduce the risk of unintended environmental contamination from chemical inputs. 8. The only chemicals that can be purchased and used with Federal grant funds are those listed in Table 4. Handling, Transporting, and Storage 1. Mixing, storage, and equipment cleaning will occur at a stationary facility equipped to accommodate these activities. 2. Field handling of chemicals, mixing, loading, transporting, and equipment cleaning must be conducted at least 100 ft from surface water. An impervious material will be placed beneath the mixing areas to contain small spills associated with mixing and refilling. 3. All equipment used for transportation, storage, or application of chemicals will be maintained in good working order and as required by law, and are in leak and spill-proof containers. 4. Chemicals will be transported in sealed containers inside a well-constructed and watertight carrying box or bucket. An appropriate container will prevent leaks in vehicles, onto applicators, or to the environment under normal conditions. 5. Provide emergency hand and eye wash facilities for applicators at storage, mixing, and field sites. Applicators will have a spill response plan and containment kit available to them on site, and will be familiar with the plan and kit use before applying herbicides. Applicators will be able to respond to accidental herbicide poisoning and be equipped with an appropriate first aid kit and a medical response plan when handling pesticides. 6. Store chemicals in a secure, dedicated facility that is well ventilated, cool, and dry. The floor should be concrete or lined with plastic or other impermeable material to prevent leaching into soil. 7. Containers should be properly labeled to show contents, the date mixed, and approximate volume remaining when placed in storage. 8. Wear appropriate protective equipment and follow all handling instructions specified on the chemical label to minimize unnecessary chemical exposure. Thoroughly clean protective gear after each use. 9. If no specific chemical container recycling program is available, puncture the empty container to prevent reuse, and then dispose of properly in a solid waste facility or destroy it. Application 1. Use of chemicals will be performed or directly supervised by a certified and licensed applicator. 2. Applicators will read and follow label safety directions, maintain appropriate Material Safety Data Sheets, and become certified prior to applying restricted use pesticides. 3. Where possible, use a non-toxic dye (e.g., Hi-Light or Dynamark) to aid in identifying target area treated as well as potential over-spray or drift. A dye can also aid in detecting equipment leaks. If a leak is discovered, the application will be stopped until repairs can be made to the sprayer. 4. Equipment will be calibrated regularly to ensure that the proper rate of chemical is applied to the target area or species. 5. Chemicals will only be applied during favorable weather conditions. Avoid applications prior to an expected heavy rainfall, during periods of atmospheric inversion or fog, and when wind conditions exceed 10 mph. 6. Avoid applications to saturated soils. Individual plants will not be spot treated with chemicals within 24 hours of the treated ground being irrigated. 7. Treat areas around lakes, ponds, and wetlands when the soils are driest. If chemicals treatment is necessary when soils are wet, use herbicides specified for aquatic use. Species Specific 1. Applicators will follow all no-spray buffers to protect surface and ground water, aquatic life, and sensitive vegetation chemicals listed in Table 5. 2. Use only aquatic-approved herbicides within 300 feet of occupied Oregon spotted frog habitat and designated critical habitat.

Additional Threshold Information:

- Malathion was moderately toxic to all species of tadpoles (median lethal concentration [LC50] values, the concentration estimated to kill 50% of a test population, ranged from 1.25-5.9 mg/L). These values are within the range of values reported for the few amphibians that have been tested (0.2-42 mg/L). In one of the six species, malathion became twice as lethal when combined with predatory stress. Similar synergistic interactions have been found with the insecticide carbaryl, suggesting that the synergy may occur in many carbamate and organophosphate insecticides. While malathion has the potential to kill amphibians and its presence is correlated with habitats containing declining populations, its actual role in amphibian declines is uncertain given the relatively low concentration in aquatic habitats. The impact of pesticides on amphibians is of particular concern because their populations appear to be declining on a global scale. We examined the toxic and genotoxic effects of malathion, a commonly used organophosphorus pesticide, in the larvae of Indian skittering frog (Euflictis cyanophlyctis). The different concentrations of malathion (0, 0.5, 1.0, 2.0, 4.0 and 8.0 mg/L) tested in a 2 × 6 factorial design, induced concentration-dependent lethality in tadpoles in the presence and absence of predator cues. The 96 h LC50 for malathion in the presence and absence of predator stress were 3.523 mg/L and 3.588 mg/L, respectively. The 15-day LC50 value for malathion was estimated to be 2.452 mg/L. Lower concentrations of malathion extending into the sublethal range (0.5, 1.0 and 2.0 mg/L) induced micronuclei (MN) in the erythrocytes of tadpoles at 24 h ($F_{3,56} = 70.291$, $p < 0.001$), 48 h ($F_{3,56} = 78.423$, $p < 0.001$), 72 h ($F_{3,56} = 88.817$, $p < 0.001$) and 96 h ($F_{3,56} = 64.770$, $p < 0.001$) in a concentration-dependent manner. Predator stress significantly enhanced the MN frequency at 48 h following 1.0 mg/L malathion treatment ($p < 0.001$). The present report is the first one to analyze genotoxic effect of malathion in the presence of predator stress. These results suggest that predator stress may potentiate the genotoxic effect of lower concentrations of malathion in E. cyanophlyctis tadpoles. These effects may have long-term fitness consequence to the population as a whole. See Table 1 of Intro Summary for specific metrics. Aquatic phase CA red-legged frog) CRLF effects. Direct effect levels of concern (LOCs) were exceeded for CRLF aquatic life stages. Both acute and chronic LOCs were exceeded for aquatic prey and are of sufficient magnitude to have a significant detrimental impact of prey base of the CRLF. Terrestrial phase CRLF effects. Direct terrestrial effects were assessed using EFED's THerps model which incorporates amphibian/reptile specific allometric equations to more accurately assess affects to CRLF. Acute dose-based RQs exceeded LOCs for small (1.4 g), medium (37 g), and large (238 g) CRLF. Acute and chronic dietary-based RQs exceeded LOCs for small frogs, which constitutes both direct (on the CRLF itself) and indirect (on frogs that may be CRLF prey) effects. Other indirect terrestrial effects were assessed using EFED's T-Rex model. Dose-based acute and chronic RQs exceeded LOCs for small mammals. Dietary-based acute and chronic RQs and dose-based acute RQs exceeded LOCs for small birds. Small mammals, birds, and herptiles are prey items of the CRLF.
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SPECIES ACCOUNT: *Rana sevosa* (dusky gopher frog)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/4/2001; Southeast Region (R4) (USFWS, 2016)

Physical Description

The dusky gopher frog has a stubby appearance due to its short, plump body, comparatively large head, and relatively short legs (Conant and Collins 1991). The coloration of its back varies in individual frogs. It ranges from an almost uniform black to a pattern of reddish brown or dark brown spots on a ground color of dark gray or brown (Goin and Netting 1940). Warts densely cover the back. The belly is thickly covered with dark spots and dusky markings from chin to mid-body (Goin and Netting 1940, Conant and Collins 1991). Males are distinguished from females by their smaller size, nuptial pad (swollen area that assists grip during breeding) on their thumbs, and paired vocal sacs on either side of the throat (Goin and Netting 1940). Richter (1998) reported mean snout-vent lengths from three years of data from dusky gopher frogs at Glen's Pond. Measurements ranged from 2.5 to 2.8 inches (in) (63.2 to 70.2 millimeters (mm)) for males and 3.1 to 3.3 in (78.0 to 82.7 mm) for females. Dusky gopher frog tadpoles are similar to those of other gopher frogs and crawfish frogs (R. areolata) (Volpe 1957, Altig et al. 2001).

Taxonomy

Gopher frogs (Rana capito and R. sevosa) are members of the large family, Ranidae (”true frogs”), which has a worldwide distribution. The genus Rana is the only North American representative of this family.

Historical Range

Historical records exist for Alabama and Louisiana, but currently no populations are known from these two states. Historic records for the dusky gopher frog exist for sites in St. Tammany Parish, Louisiana; Forrest, Greene, Hancock, Harrison, Jackson, Pearl River, and Perry Counties in Mississippi; and Mobile County, Alabama (Allen 1932, Netting and Goin 1942, Smith and List 1955, Neill 1957, Volpe 1957, Crawford 1988, Dundee and Rossman 1989, HerpNet 2013).

Current Range

Its current distribution is restricted to the state of Mississippi, in Harrison and Jackson counties. At the time of listing, only one population of the species was known. Subsequently, two other naturally-occurring populations were discovered. One additional dusky gopher frog population has been established in Mississippi as a result of translocation experiments

Critical Habitat Designated

Yes; 6/12/2012.

Legal Description

On June 12, 2012, the U.S. Fish and Wildlife Service designated critical habitat for the dusky gopher frog under the Endangered Species Act. In previous publications, the Service used the common name ‘‘Mississippi gopher frog’’ for this species. The Service is taking this action to fulfill obligations under the Act. Land in St. Tammany Parish, Louisiana, and Forrest, Harrison, Jackson, and Perry Counties, Mississippi, was designated under a court approved settlement agreement to finalize critical habitat for the species.

Critical Habitat Designation

15 units/subunits are designated as critical habitat for the dusky gopher frog:

Unit 1: St. Tammany Parish, Louisiana Unit 1 encompasses 625 ha (1,544 ac) on private lands managed for industrial forestry in St. Tammany Parish, Louisiana. This unit is located north and south of State Hwy. 36, approximately 3.1 km (1.9 mi) west of State Hwy. 41 and the town of Hickory, Louisiana. Unit 1 is not within the geographic area occupied by the species at the time of listing. It is currently unoccupied; however, the last observation of a dusky gopher frog in Louisiana was in 1965 in one of the ponds within this unit. Unit 1 consists of five ponds (ephemeral wetland habitat) and their associated uplands. If dusky gopher frogs are translocated to the site, the five ponds are in close enough proximity to each other that adult frogs could move between them and create a metapopulation, which increases the chances of the long-term survival of the population. Although the uplands associated with the ponds do not currently contain the essential physical or biological features of critical habitat, we believe them to be restorable with reasonable effort. Due to the low number of remaining populations and severely restricted range of the dusky gopher frog, the species is at high risk of extirpation from stochastic events, such as disease or drought. Maintaining the five ponds within this area as suitable habitat into which dusky gopher frogs could be translocated is essential to decrease the risk of extinction of the species resulting from stochastic events and provide for the species' eventual recovery. Therefore, we have determined this unit is essential for the conservation of the species because it provides important breeding sites for recovery. It includes habitat for population expansion outside of the core population areas in Mississippi, a necessary component of recovery efforts for the dusky gopher frog.

Unit 2: Harrison County, Mississippi Unit 2 comprises two subunits encompassing 549 ha (1,356 ac) on Federal and private lands in Harrison County, Mississippi. This unit, between U.S. Hwy. 49 and Old Hwy. 67, is approximately 224 m (735 ft) northeast of the Biloxi River. It is located approximately 2.8 km (1.8 mi) east of U.S. Hwy. 49 and approximately 2.3 km (1.4 mi) west of Old Hwy. 67. Within this unit, approximately 525 ha (1,297 ac) are in the DNF and 24 ha (59 ac) are in private ownership. Subunit A Unit 2, Subunit A encompasses 121 ha (299 ac) around the only breeding pond (Glen's Pond) known for the dusky gopher frog when it was listed in 2001; as a result, it is within the geographic area of the species occupied at the time of listing. In addition, this subunit contains all elements of the essential physical or biological features of the species. The majority of this subunit (100 ha (247 ac)) is in the DNF, with the remainder (21 ha (52 ac)) in private ownership. This subunit is being designated as critical habitat because it was occupied at the time of listing, is currently occupied, and contains sufficient primary constituent elements (ephemeral wetland habitat (PCE 1), upland forested nonbreeding habitat (PCE 2), and upland connectivity habitat (PCE 3)) to support life-history functions essential to the conservation of the species. Glen's Pond and the habitat surrounding it, consisting of forested uplands used as nonbreeding habitat and upland connectivity habitat between breeding and nonbreeding habitat, support the majority of the dusky gopher frogs that currently exist in the wild. Within Unit 2, Subunit A, the dusky gopher frog and its habitat may require special management considerations or protection to address potential adverse effects caused by: Fire suppression and low fire frequencies; detrimental alterations in forestry practices that could destroy belowground soil structures, such as stump removal; hydrologic changes resulting from ditches, and/or adjacent highways and roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat; wetland degradation; random effects of drought or floods; off-road vehicle use; gas, water, electrical power, and sewer easements; and agricultural and urban development. Subunit B Unit 2, Subunit B encompasses 428 ha (1,057 ac) adjacent to Subunit A and the area surrounding Glen's Pond. The majority of this subunit (425 ha (1,050 ac)) is in the DNF, with the remainder (3 ha (7 ac)) in private ownership. This subunit is not within the geographic area of the species occupied at the time of listing and is currently unoccupied. However, we believe this subunit is essential for the conservation of the dusky gopher frog because it consists of areas, within the dispersal range of the dusky gopher frog (from Subunit A), which we believe provide important breeding sites for recovery and metapopulation structure that will protect the dusky gopher frog from extinction. This unoccupied area consists of three ponds and their associated uplands in the DNF. These ponds were named Reserve Pond, Pony Ranch Pond, and New Pond during our ongoing recovery initiatives. The USFS is actively managing this area to benefit the recovery of the dusky gopher frog. Due to the low number of remaining populations and the severely restricted range of the dusky gopher frog, the species is at high risk of extirpation from stochastic events, such as disease or drought. Maintaining this area as suitable habitat into which dusky gopher frogs could be translocated is essential to decrease the risk of extinction of the species resulting from stochastic events and provide for the species' eventual recovery.

Unit 3: Harrison County, Mississippi Unit 3 encompasses 121 ha (299 ac) on Federal land in Harrison County, Mississippi. This unit is located in the DNF approximately 7.9 km (4.9 mi) east of the community of Success at Old Hwy. 67 and 4 km (2.5 mi) south of Bethel Road. Unit 3 is not within the geographic range of the species occupied at the time of listing and is currently unoccupied. This area surrounds a pond on the DNF that was given the name of Carr Bridge Road Pond during ongoing recovery initiatives when it was selected as a dusky gopher frog translocation site. The USFS is actively managing this area to benefit the recovery of the dusky gopher frog. Due to the low number of remaining populations and severely restricted range of the dusky gopher frog, the species may be at risk of extirpation from stochastic events, such as disease or drought. Maintaining this area as suitable habitat into which dusky gopher frogs could be translocated is essential to decrease the potential risk of extinction of the species resulting from stochastic events and to provide for the species' eventual recovery. Therefore, this unit is being designated as critical habitat because it is essential for the conservation of the species.

Unit 4: Jackson County, Mississippi Unit 4 encompasses 278 ha (687 ac) on Federal and private land in Jackson County, Mississippi. This unit borders the north side of Interstate 10 approximately 1.1 km (0.7 mi) west of State Hwy. 57. Within this unit, approximately 48 ha (119 ac) are in the Mississippi Sandhill Crane National Wildlife Refuge and 230 ha (568 ac) are in private ownership. Subunit A Unit 4, Subunit A encompasses 121 ha (299 ac) on private land. It is currently occupied as a result of translocation efforts conducted in 2004, 2005, 2007, 2008, 2009, and 2010; however, it was not occupied at the time of listing. We believe this subunit is essential for the conservation of the dusky gopher frog because of the presence of a proven breeding pond (egg masses have been deposited here in 2007 and 2010 by gopher frogs translocated to the site) and its associated uplands (upland forested nonbreeding habitat and upland connectivity habitat). We also believe that metapopulation structure, which will further protect the dusky gopher frog from extinction, is possible when the whole area of Unit 4 is considered. The private owners of this property are actively managing this area to benefit the recovery of the dusky gopher frog. Due to the low number of remaining populations and severely restricted range of the dusky gopher frog, the species may be at high risk of extirpation from stochastic events, such as disease or drought. Maintaining this area as suitable habitat into which dusky gopher frogs can continue to be translocated is essential to decrease the risk of extinction of the species resulting from stochastic events and provide for the species' eventual recovery. Subunit B Unit 4, Subunit B encompasses 157 ha (388 ac) on Federal and private land adjacent to Subunit A. The majority of this subunit (109 ha (269 ac)) is on private land, with the remainder of the unit (48 ha (119 ac)) in the Mississippi Sandhill Crane National Wildlife Refuge. This subunit is not within the geographic area of the species occupied at the time of listing and is currently unoccupied. However, we believe this subunit is essential for the conservation of the dusky gopher frog because it consists of an area, within the dispersal range of the dusky gopher frog (from Subunit A), which provides two important breeding sites and their associated upland for recovery and metapopulation structure that will protect the dusky gopher frog from extinction. This area is actively managed to benefit the recovery of the dusky gopher frog. Due to the low number of remaining populations and severely restricted range of the dusky gopher frog, the species may be at risk of extirpation from stochastic events, such as disease or drought. Maintaining this area as suitable habitat is essential to decrease the potential risk of extinction of the species and provide for the species' eventual recovery.

Unit 5: Jackson County, Mississippi Unit 5 encompasses 175 ha (432 ac) on private land in Jackson County, Mississippi. This unit is located approximately 10.6 km (6.6 mi) north of Interstate 10. It is 124 m (407 ft) north of Jim Ramsey Road and 5.7 km (3.6 mi) west of the community of Vancleave located near State Hwy. 57. Subunit A Unit 5, Subunit A encompasses 121 ha (299 ac) on private land. It is currently occupied, but was not known to be occupied at the time of listing. This subunit contains a breeding site where dusky gopher frogs were discovered in 2004, subsequent to the listing of the dusky gopher frog. We believe this subunit is essential for the conservation of the dusky gopher frog because of the presence of a proven breeding pond, named Mike's Pond (ephemeral wetland habitat), and its associated uplands (upland forested nonbreeding habitat and upland connectivity habitat). We also believe that metapopulation structure, which will further protect the dusky gopher frog from extinction, is possible when the whole area of Unit 5 is considered. The owners of this property are actively managing this area to benefit the recovery of the dusky gopher frog. Due to the low number of remaining populations and severely restricted range of the dusky gopher frog, the species may be at high risk of extirpation from stochastic events, such as disease or drought. Maintaining this area as suitable habitat is essential to decrease the risk of extinction of the species resulting from stochastic events and provide for the species' eventual recovery. Subunit B Unit 5, Subunit B encompasses 54 ha (133 ac) on private land adjacent to Subunit A. This subunit is not within the geographic area of the species occupied at the time of listing and is currently unoccupied. However, we believe this subunit is essential for the conservation of the dusky gopher frog because it consists of an area, within the dispersal range of the dusky gopher frog (from Subunit A), which provides an important breeding site and associated forested uplands for recovery and metapopulation structure that will protect the dusky gopher frog from extinction. This unoccupied area consists of a single pond and its associated uplands. This area is actively managed to benefit the recovery of the dusky gopher frog. Due to the low number of remaining populations and severely restricted range of the dusky gopher frog, the species may be at risk of extirpation from stochastic events, such as disease or drought. Maintaining this area as suitable habitat is essential to decrease the potential risk of extinction of the species and provide for the species' eventual recovery.

Unit 6: Jackson County, Mississippi Unit 6 encompasses 121 ha (299 ac) on Federal land in Jackson County, Mississippi. This unit is located on the Ward Bayou Wildlife Management Area (WMA) approximately 4.8 km (3 mi) northeast of State Hwy. 57 and the community of Vancleave.

This land is owned by the U.S. Army Corps of Engineers (Corps) and managed by the Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP) to benefit the recovery of the dusky gopher frog. Unit 6 is not within the geographic range of the species occupied at the time of listing and is currently unoccupied. This area consists of a pond and its associated uplands on the WMA and has been given the name of Mayhaw Pond during ongoing recovery initiatives. We believe this area is essential for the conservation of the dusky gopher frog because it provides an important breeding site and associated forested uplands for recovery. Due to the low number of remaining populations and severely restricted range of the dusky gopher frog, the species may be at risk of extirpation from stochastic events, such as disease or drought. Maintaining this area of suitable habitat, into which dusky gopher frogs could be translocated, is essential to decrease the potential risk of extinction of the species and provide for the species' eventual recovery.

Unit 7: Jackson County, Mississippi Unit 7 encompasses 121 ha (299 ac) on State and private land in Jackson County, Mississippi. This unit is located approximately 4.2 km (2.6 mi) east of the intersection of State Hwy. 63 and State Hwy. 613; it is 3.8 km (2.4 mi) west of the Escatawpa River, and 3.2 km (2 mi) northeast of Helena, Mississippi. The portion of this unit in State ownership (107 ha (264 ac)) is 16th section land held in trust by the State of Mississippi as a local funding source for public education in Jackson County. The Jackson County School board has jurisdiction and control of the land. The balance of this unit is on private land (14 ha (35 ac)). Unit 7 is currently occupied, but was not known to be occupied at the time of listing. The area, discovered in 2004 subsequent to the listing of the dusky gopher frog, contains a breeding pond named McCoy's Pond and associated uplands. We believe this area is essential for the conservation of the species because it provides an important breeding site and associated forested uplands for recovery of the dusky gopher frog. Currently, the State-owned portion of the area is managed for timber production by the Mississippi Forestry Commission for the Jackson County School Board. Due to the low number of remaining populations and severely restricted range of the dusky gopher frog, it may be at high risk of extirpation from stochastic events, such as disease or drought. Maintaining this area of currently occupied habitat for dusky gopher frogs is essential to decrease the risk of extinction of the species and provide for the species' eventual recovery.

Unit 8: Forrest County, Mississippi Unit 8 encompasses 121 ha (299 ac) on Federal land in Forrest County, Mississippi. This unit is located in the DNF approximately 1.9 km (1.2 mi) east of U.S. Hwy. 49, approximately 1.7 km (1.1 mi) south of Black Creek, and approximately 3.1 km (1.9 mi) southeast of the community of Brooklyn, Mississippi. Unit 8 is not within the geographic range of the species occupied at the time of listing and is currently unoccupied. This area consists of a pond and associated uplands that have been selected as a future dusky gopher frog translocation site during ongoing recovery initiatives. We believe this area is essential for the conservation of the species because it provides an important breeding site and associated forested uplands for recovery of the dusky gopher frog. Unit 8 is being actively managed by the USFS to benefit the recovery of the dusky gopher frog. Due to the low number of remaining populations and severely restricted range of the dusky gopher frog, the species may be at risk of extirpation from stochastic events, such as disease or drought. Maintaining this area as suitable habitat, into which dusky gopher frogs could be translocated, is essential to decrease the potential risk of extinction of the species and provide for the species' eventual recovery.

Unit 9: Forrest County, Mississippi Unit 9 encompasses 121 ha (299 ac) on Federal land and private land in Forrest County, Mississippi. The majority of this unit (120 ha (297 ac)) is located in the DNF and the balance (1 ha (2.5 ac)) on private land. This unit is located approximately 3.9 km (2.4 mi) east of U.S. Hwy. 49, approximately 4.3 km (2.7 mi) south of Black Creek, and approximately 6.1 km (3.8 mi) southeast of the community of Brooklyn, Mississippi, at the Perry County line. Unit 9 is not within the geographic range of the species occupied at the time of listing and is currently unoccupied. This area consists of a pond and associated uplands that have been selected as a future dusky gopher frog translocation site during ongoing recovery initiatives. We believe this area is essential for the conservation of the species because it provides an important breeding site and associated forested uplands for recovery of the dusky gopher frog. Most of Unit 9 is being actively managed by the USFS to benefit the recovery of the dusky gopher frog. Due to the low number of remaining populations and severely restricted range of the dusky gopher frog, the species may be at risk of extirpation from stochastic events, such as disease or drought. Maintaining this area as suitable habitat, into which dusky gopher frogs could be translocated, is essential to decrease the potential risk of extinction of the species and provide for the species' eventual recovery.

Unit 10: Perry County, Mississippi Unit 10 encompasses 147 ha (363 ac) on Federal land and private land in Perry County, Mississippi. The majority of this unit (127 ha (314 ac)) is located in the DNF and the balance (20 ha (49 ac)) is located on private land. This unit is located at the intersection of Benndale Road and Mars Hill Road, approximately 2.6 km (1.6 mi) northwest of the intersection of the Perry County, Stone County, and George County lines and approximately 7.2 km (4.5 mi) north of State Hwy. 26. Unit 10 is not within the geographic range of the species occupied at the time of listing and is currently unoccupied. This area consists of two ponds and their associated uplands that have been selected as future dusky gopher frog translocation sites during ongoing recovery initiatives. It provides the habitat for establishing new breeding ponds and metapopulation structure that will protect the dusky gopher frog from extinction. We believe this area is essential for the conservation of the dusky gopher frog because it provides two important breeding sites and their associated forested uplands for recovery of the dusky gopher frog. Most of Unit 10 is being actively managed by the USFS to benefit the recovery of the dusky gopher frog. Due to the low number of remaining populations and severely restricted range of the dusky gopher frog, the species may be at high risk of extirpation from stochastic events, such as disease or drought. Maintaining this area as suitable habitat, into which dusky gopher frogs could be translocated, is essential to decrease the risk of extinction of the species and provide for the species' eventual recovery.

Unit 11: Perry County, Mississippi Unit 11 encompasses 121 ha (299 ac) on Federal land and private land in Perry County, Mississippi. The majority of this unit (119 ha (294 ac)) is located in the DNF and the balance (2 ha (5 ac)) is located on private land. This unit borders the north side of Benndale Road northeast of the intersection of the Perry County, Stone County, and George County lines, approximately 6.4 km (4 mi) north of State Hwy. 26. Unit 11 is not within the geographic range of the species occupied at the time of listing and is currently unoccupied. This area consists of a pond and associated uplands that have been selected as a future dusky gopher frog translocation site during ongoing recovery initiatives. We believe this area is essential for the conservation of the gopher dusky frog because it provides an important breeding site and associated forested uplands for recovery of the dusky gopher frog. Most of Unit 11 is being actively managed by the USFS to benefit the recovery of the dusky gopher frog. Due to the low number of remaining populations and severely restricted range of the dusky gopher frog, the species may be at risk of extirpation from stochastic events, such as disease or drought. Maintaining this area as suitable habitat, into which dusky gopher frogs could be translocated, is essential to decrease the potential risk of extinction of the species and provide for the species' eventual recovery.

Unit 12: Perry County, Mississippi Unit 12 encompasses 121 ha (299 ac) on Federal land and private land in Perry County, Mississippi. The majority of this unit (115 ha (284 ac)) is located in the DNF and the remaining balance (6 ha (15 ac)) is located on private land. This unit is located approximately 1.2 km (0.75 mi) east of Mars Hill Road, approximately 3.9 km (2.4 mi) north of the intersection of the Perry County, Stone County, and George County lines, and approximately 10.2 km (6.4 mi) north of State Hwy. 26. Unit 12 is not within the geographic range of the species occupied at the time of listing and is currently unoccupied. This area consists of a pond and its associated uplands that have been selected as a future dusky gopher frog translocation site during ongoing recovery initiatives. We believe this area is essential for the conservation of the dusky gopher frog because it provides an important breeding site and associated forested uplands for recovery of the dusky gopher frog. Most of Unit 12 is being actively managed by the USFS to benefit the recovery of the dusky gopher frog. Due to the low number of remaining populations and severely restricted range of the dusky gopher frog, the species may be at risk of extirpation from stochastic events such as disease or drought. Maintaining this area as suitable habitat into which dusky gopher frogs could be translocated is essential to decrease the potential risk of extinction of the species and provide for the species' eventual recovery.

Primary Constituent Elements/Physical or Biological Features

Critical habitat units are designated for St. Tammany Parish, Louisiana, and Forrest, Harrison, Jackson, and Perry Counties in Mississippi. Within these areas, the primary constituent elements of the physical or biological features essential to the conservation of the dusky gopher frog are:

(i) Ephemeral wetland habitat. Breeding ponds, geographically isolated from other waterbodies and embedded in forests historically dominated by longleaf pine communities, that are small (generally <0.4 to 4.0 hectares (<1 to 10 acres)), ephemeral, and acidic. Specific conditions necessary in breeding ponds to allow for successful reproduction of dusky gopher frogs are: (A) An open canopy with emergent herbaceous vegetation for egg attachment; (B) An absence of large, predatory fish that prey on frog larvae; (C) Water quality such that frogs, their eggs, or larvae are not exposed to pesticides or chemicals and sediment associated with road runoff; and (D) Surface water that lasts for a minimum of 195 days during the breeding season to allow a sufficient period for larvae to hatch, mature, and metamorphose.

(ii) Upland forested nonbreeding habitat. Forests historically dominated by longleaf pine, adjacent to and accessible to and from breeding ponds, that are maintained by fires frequent enough to support an open canopy and abundant herbaceous ground cover and gopher tortoise burrows, small mammal burrows, stump holes, or other underground habitat that the dusky gopher frog depends upon for food, shelter, and protection from the elements and predation.

(iii) Upland connectivity habitat. Accessible upland habitat between breeding and nonbreeding habitats to allow for dusky gopher frog movements between and among such sites. This habitat is characterized by an open canopy, abundant native herbaceous species, and a subsurface structure that provides shelter for dusky gopher frogs during seasonal movements, such as that created by deep litter cover, clumps of grass, or burrows.

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.

All areas occupied at the time of listing will require some level of management to address the current and future threats to the dusky gopher frog and to maintain or restore the PCEs. Unoccupied areas will also require management to complete restoration. The features essential to the conservation of this species may require special management considerations or protection to reduce various threats to critical habitat that may affect one or more of the PCEs. Special management of ephemeral wetland habitats ((breeding sites (PCE 1)) will be needed to ensure that these areas provide water quantity, quality, and appropriate hydroperiod; cover; and absence from levels of predation and disease that can affect population persistence. In nonbreeding upland forested habitat (PCEs 2 and 3), special management will be needed to ensure an open canopy and abundant herbaceous ground cover; underground habitat for adult and subadult frogs to occupy; and sufficient cover as frogs migrate to and from breeding sites. A detailed discussion of activities influencing the dusky gopher frog and its habitat can be found in the final listing rule (66 FR 62993; December 4, 2001). Activities that may warrant special management of the physical or biological features that define essential habitat (appropriate quantity and distribution of PCEs) for the dusky gopher frog include, but are not limited to: (1) Land use conversions, primarily urban development and conversion to agriculture and pine plantations; (2) stump removal and other soil-disturbing activities that destroy the belowground structure within forest soils; (3) fire suppression and low fire frequencies; (4) wetland destruction and degradation; (5) random effects of drought or floods; (6) off-road vehicle use; (7) maintenance of gas, water, electrical power, and sewer easements; and (8) activities that disturb underground refugia used by dusky gopher frogs for foraging, protection from predators, and shelter from the elements.

Special management considerations or protection are required within critical habitat areas to address the threats identified above. Management activities that could ameliorate these threats include (but are not limited to): (1) Maintaining critical habitat areas as forested pine habitat (preferably longleaf pine); (2) conducting forestry management using prescribed burning, avoiding the use of beds when planting trees, and reducing planting densities to create or maintain an open canopied forest with abundant herbaceous ground cover; (3) maintaining forest underground structure such as gopher tortoise burrows, small mammal burrows, and stump holes; (4) and protecting ephemeral wetland breeding sites from chemical and physical changes to the site that could occur by presence or construction of ditches or roads.

Life History

Food/Nutrient Resources

Food Source

Larvae: Periphyton, algae

Adult: Terrestrial invertebrates, fossorial invertebrates, terrestrial vertebrates

Food/Nutrient Narrative

Larvae: Dusky gopher frog larvae are likely filter-feeders in their pond's water column and also grazers on periphyton and epiphytic algae, as is typical of most tadpoles (Duellman and Trueb 1986, Alford 1999, Hoff et al. 1999).

Adult: Little information is available regarding the food habits of dusky gopher frogs. Netting and Goin (1942) provide the only published account for the diet of an adult dusky gopher frog and described finding carabid (Pasimachus sp.) and scarabaeid (generaCanthon sp. and Ligryus sp.) beetles in the gut of one specimen. Adult dusky gopher frogs are carnivorous and likely have a diet similar to that reported for other species of gopher frogs which includes frogs, toads, small mammals, beetles, hemipterans, grasshoppers, spiders, roaches, and earthworms (Deckert 1920, Carr 1940, Dickerson 1969, Blihovde, USFWS, pers. comm. 2005).

Reproductive Strategy

Adult: R-Selected, oviparity, colonial

Lifespan

Adult: 3 - 12 years

Breeding Season

Adult: Typically December - March, but may occur in late summer and fall

Key Resources Needed for Breeding

Adult: Ephemeral ponds, upland connectivity habitat, rains associated with cold fronts, aquatic herbaceous vegetation

Reproduction Narrative

Egg: Dusky gopher frog egg masses take 9 to 21 days to complete hatching; the hatching rate is driven by water temperature (Richter and Seigel, unpublished data, Baxley and Qualls 2007).

Larvae: Metamorphosis occurs from mid-May to early August at Glen's Pond (Richter et al. 2003, Sisson et al. 2008). Tadpoles develop in the pond and may metamorphose as early as 94 days after hatching (Pechmann pers. comm. 2014); however, if the breeding pond continues to hold water, tadpoles may gain mass and metamorphose after a longer period. The date that metamorphosis begins appears to be unaffected by oviposition date and over-wintering of dusky gopher frog tadpoles has been documented (Sisson 2003, Pechmann and Tupy 2010).

Adult: Breeding sites are ephemeral (seasonally flooded) ponds not connected to other water bodies (isolated) (Kirkman et al. 2007) with an open canopy (Thurgate and Pechmann 2007). During the breeding season, dusky gopher frogs leave their subterranean retreats in the uplands and migrate to their breeding sites during rains associated with passing cold fronts (Young 1997). Although breeding typically occurs from December through March, reproduction has been documented in all months except May, June and July. Late summer and autumn breeding has occurred after heavy rains from tropical depressions and hurricanes in August, September and October (Seigel and Kennedy 1999, Thurgate and Pechmann 2007, Pechmann and Tupy 2012). Male dusky gopher frogs move to breeding ponds before females and begin calling (Richter and Seigel 2002); however, males may call below water and calls may be difficult to detect (Dundee and Rossman 1989, Jensen et al. 1995). Females typically arrive at the pond, breed, deposit their eggs as a single clutch on emergent herbaceous vegetation (Goin and

Netting 1940, Dundee and Rossman 1989, Young et al. 1995, Richter and Seigel 2002, Richter et al. 2003), and leave the pond; males generally remain at the pond longer. The number of eggs per egg mass ranges from 500 to 2,800 in Mississippi (Richter and Seigel 1997, 1998; Young 1997, Richter 1998), to 3,000 to 7,000 in Louisiana (Volpe 1957, Dundee and Rossman 1989). After breeding, adult dusky gopher frogs leave pond sites during rainfall events and move to terrestrial belowground refugia.In the wild, male dusky gopher frogs attain adult size and become reproductively mature at age 1 to 5 years and females at 2 to 5 years (Richter and Seigel 2002, Pechmann et al. 2012). Results from field enclosure experiments indicate timing to maturity can take up to 5 years depending on habitat quality (J. Tupy, Western Carolina University, pers. comm. 2013). The estimated maximum longevity, based on mark-recapture data, for male dusky gopher frogs is 9 years and 12 years for females (Pechmann et al. 2012). However, only an estimated one quarter of males live longer than 3 years, and only one third of females live longer than 5 years (Richter and Seigel 2002, Pechmann et al. 2012). Frogs breed, on average, only one to two seasons during their lifetime (Richter and Seigel 2002, Pechmann et al. 2012). Studies at the Mississippi breeding site suggest that female dusky gopher frogs do not breed until at least 2 to 3 years of age and only average one to two lifetime breeding events (Richter et al. 2003, Pechmann et al. 2012). In addition, larval survival at Glen's Pond is extremely low (Richter et al. 2003, Pechmann et al. 2012).

Habitat Type

Egg: Freshwater

Larvae: Freshwater

Juvenile: Freshwater, terrestrial

Adult: Terrestrial, fossorial, freshwater

Habitat Vegetation or Surface Water Classification

Egg: Freshwater: Palustrine - wetland, riparian, ephemeral pool

Larvae: Freshwater: Palustrine - wetland, riparian, ephemeral pool

Juvenile: Terrestrial: Conifer woodland, Freshwater: Palustrine - wetland, riparian, ephemeral pool

Adult: Terrestrial: Conifer woodland, Freshwater: Palustrine - wetland, riparian, ephemeral pool

Dependencies on Specific Environmental Elements

Larvae: Acidic wetland

Juvenile: Periodic fires

Adult: Periodic fires

Geographic or Habitat Restraints or Barriers

Adult: Roads, development

Spatial Arrangements of the Population

Juvenile: Small subpopulations distributed among breeding ponds

Adult: Small subpopulations distributed among breeding ponds

Dependency on Other Individuals or Species for Habitat

Juvenile: Gopher tortoise (Gopherus polyphemus)

Adult: Gopher tortoise (Gopherus polyphemus)

Habitat Narrative

Larvae: Larval habitat consists of grassy, acidic, isolated, ephemeral, depressional wetlands that lack predaceous fish.

Juvenile: For juvenile habitat see adult narrative.

Adult: Dusky gopher frogs are amphibians with a complex life cycle that consists of aquatic eggs/larvae and terrestrial adults. Optimal post-larval dusky gopher frog habitat consists of uplands dominated by fire-maintained longleaf pine (Pinus palustris) with a grassy understory. Adult and subadult dusky gopher frogs spend the majority of their lives underground, generally in stump holes or small mammal burrows within their forested habitat (Richter et al. 2001, Tupy 2012). Historically, they were frequently found in active and abandoned gopher tortoise (Gopherus polyphemus) burrows (Allen 1932). Forested habitat consists of fire-maintained, open-canopied woodlands historically dominated by longleaf pine (Pinus palustris) with an understory of grasses such as little bluestem (Schizachyrium scoparium). Dusky gopher frog habitat includes both upland sandy and sandy loam habitats—historically forest dominated by longleaf pine—and wetland breeding sites embedded within the forested landscape.Separation barriers include 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. Published studies of population dynamics in gopher frogs (R. capito) indicate that their populations are naturally (but often only historically) distributed across the landscape among multiple breeding ponds interconnected by suitable upland habitat; they may have small local/pond subpopulation sizes, which cumulatively can form large populations (Semlitsch et al. 1995, Greenberg 2001, Richter et al. 2009).

Dispersal/Migration

Motility/Mobility

Juvenile: Moderate

Adult: Moderate

Dispersal

Juvenile: Low

Adult: Low

Dispersal/Migration Narrative

Juvenile: Metamorphic frogs leave pond sites during rainfall events and move to terrestrial belowground refugia once their development is complete.

Adult: Richter et al. (2001) used radio transmitters to track a total of 13 adult frogs from Glen's Pond to their primary upland retreats. The farthest movement recorded was 981 feet (ft) (299 meters (m)) by a frog tracked for 63 days from the time of its exit from the breeding site (Richter et al. 2001). Tupy (2012) conducted a more recent radio telemetry study of 17 dusky gopher frogs captured at Glen's Pond. The maximum distance traveled by one of these frogs to its underground refuge was 787 ft (240 m). In 2013, dusky gopher frogs from the Glen's Pond population moved 0.8 mi (1.3 km) to Pony Ranch Pond where they bred (Pechmann and Tupy 2013).Connectivity of dusky gopher frog breeding and nonbreeding habitat within the geographic area occupied by the species must be maintained to support the species' survival (Semlitsch 2002, Rothermel 2004, Harper et al. 2008, Richter et al. 2009, Richter and Nunziata 2013). This connectivity allows for 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).

Population Information and Trends

Population Trends:

Not available

Species Trends:

Increasing (USFWS, 2015b)

Number of Populations:

1 Wild; 7 reintroduced (USFWS, 2021)

Population Size:

~249 wild (USFWS, 2021)

Resistance to Disease:

Low in tadpoles (See Threats)

Adaptability:

Low

Population Narrative:

Presently, the USFWS estimates that a minimum of 135 individual adult frogs survive in the wild, the vast majority of which occur in the original population known at the time of listing. The Glen's Pond population, supported by the Glen's Pond and Pony Ranch Pond breeding sites, is the only population that is considered stable at this time. Only three small, isolated, naturally-occurring populations have been documented since 2001 and their distribution is limited from what was once likely a larger, connected complex of subpopulations and breeding ponds. The genetic and population ecology data available for the dusky gopher frog illustrate the consequences of geographic range collapse and geographic isolation of populations: reduced overall population sizes, increased negative effects of variation in reproductive success, inbreeding-related mortality, low genetic diversity, and elevated probability of extinction

(Richter et al. 2009, Richter and Nunziata 2013). At the time of the last 5-year review there was one known wild population and two reintroduced populations of the dusky gopher frog. Currently there is one known wild population, and seven reintroduced populations. (USFWS, 2021). It is estimated that 249 adult dusky gopher frogs breeding in the wild, with the majority at Glen's Pond. (USFWS, 2021)

Threats and Stressors

Stressor: Degradation and destruction of habitat
Exposure:
Response:
Consequence:
Narrative: The dusky gopher frog is an endemic of the longleaf pine ecosystem. Outside of occupied habitat and those areas managed as potential translocation sites, the remaining parts of this ecosystem within the historical range of the frog continue to decline through fragmentation and destruction, primarily as a result of urbanization from residential and commercial development. In addition, management of remaining natural areas of the longleaf pine ecosystem is inadequate (e.g., limited use of prescribed fire as a management tool). Optimal terrestrial microhabitat, within burrows of the threatened gopher tortoise, continues to decline as gopher tortoise populations are diminished (Hinderliter 2015) (USFWS, 2015).

Stressor: Habitat fragmentation
Exposure:
Response:
Consequence:
Narrative: Habitat fragmentation of the longleaf pine ecosystem, resulting from habitat conversion, threatens the survival of the remaining dusky gopher frog populations. Even large tracts of intact longleaf pine habitat are fragmented by roads and pine plantations. Roads contribute to habitat fragmentation by isolating blocks of remaining contiguous habitat. This fragmentation may disrupt migration routes and dispersal of individuals to and from breeding sites and result in the death of dusky gopher frogs when they are attempting to cross roads. Extant dusky gopher frog populations are widely separated from each other by unsuitable habitat. Studies have shown that the loss of small, fragmented populations is common, and recolonization is critical for their regional survival (Fahrig and Merriam 1994, Burkey 1995, Marsh and Trenham 2001). As patches of available habitat become separated beyond the dispersal range of a species, disruption of metapopulation dynamics occurs and populations become more sensitive to genetic, demographic, and environmental variability and may be unable to sustain themselves (Gilpin 1987, Sjogren 1991, Blaustein et al. 1994). Dusky gopher frogs, not existing as part of a metapopulation, may be unable to recolonize areas after local extinctions due to their physiological constraints, relatively low mobility, and site fidelity (Blaustein et al. 1994). The isolation of dusky gopher frog populations eliminates the possibility of reestablishment occurring naturally and brings into question the long-term viability of the species (USFWS, 2015).

Stressor: Alteration of hydrological patterns due to urbanization and climate change
Exposure:
Response:
Consequence:

Narrative: Breeding events can be unpredictable (and may become more so with climate change), and the likelihood that recruitment will occur in a given year cannot be predicted. Higher temperatures that may result from climate change could reduce the hydroperiod of breeding ponds (USFWS, 2015).

Stressor: Small number of populations
Exposure:
Response:
Consequence:
Narrative: Small populations are at increased threat from natural processes and random events (genetic isolation, inbreeding, and drought) as well as the threats listed above. Inbreeding depression and loss of genetic diversity may also occur in small populations and reduce the fitness of individuals and the ability of the population to adapt to change (Frankel and Soule 1981), as well as increase their vulnerability to environmental stressors (Weyrauch and Grubb 2006).

Stressor: Disease
Exposure:
Response:
Consequence:
Narrative: A lethal disease killed most gopher frog tadpoles at the Glen's Pond site in 2003 (Overstreet and Lotz 2004). Recent monitoring indicates this disease, an unnamed protist (Dermomycoides sp., also known as "Perkinsus-like" disease (Green et al. 2003, Jones et al. 2012)) is still present at the site, but mortality is sporadic and has never been as high as that which occurred during the first episode. The disease has also recently caused mortality of dusky gopher frog tadpoles at Pony Ranch Pond (Pechmann and Tupy 2014), the site where the disease was originally observed in Mississippi in 2001. Fortunately, this disease does not appear to negatively affect adult dusky gopher frogs (USFWS, 2015).

Stressor: Predation
Exposure:
Response:
Consequence:
Narrative: Predation may be a threat to the dusky gopher frog. Predation is expected to be high as survivorship from the egg stage to adulthood is typically low for ranid frogs (reviewed in Richter et al. 2003). No published records of predation on adults or juvenile dusky gopher frogs exist, but predators would be similar to those of other gopher frog and ranid species (e.g., snakes, birds, and mammals; Jensen and Richter 2005, Pechmann and Tupy 2010). Richter (2000) reported an undetermined amount of the egg mortality due to predation by caddisfly larvae (Order Trichoptera, Family Phryganeidae) on the egg masses. Caddisfly infestations of dusky gopher frog egg masses have been variable since the time of listing (Baxley and Qualls 2007); however, they do not currently pose a threat to the species. No other direct documentation of egg or larval predation on dusky gopher frogs exists, but potential predators include those observed feeding on southern leopard frog eggs (Rana sphenocephala) and larvae in Glen's Pond and those of other gopher frog species. These potential predators include dragonfly naiads (Odonata), backswimmers (Hemiptera), giant water bugs (Hemiptera), predaceous diving beetles (Coleoptera), fish, salamanders, snakes, turtles, and birds (Jensen and Richter 2005, Richter pers. comm. 2013). Predation from fishes likely contributed to the loss of historic populations.

Predation on amphibians by the red imported fire ant (Solenopsis invicta) has been reported in the literature (Allen et al. 2004) and these ants have been observed at Glen's Pond and caused the death of at least one gopher frog (Pechmann and Thurgate 2001) (USFWS, 2015).

Stressor: Fire suppression
Exposure:
Response:
Consequence:
Narrative: Fire is the preferred habitat management tool used to maintain the natural longleaf pine community. Fire suppression of naturally-occurring fire and low fire frequencies have the potential of reducing the quality of terrestrial and aquatic habitat for the dusky gopher frog. Urban areas are being developed around dusky gopher frog habitat and, as a result, it is becoming more challenging to conduct prescribed burns. Drought has also contributed to a reduction in the number of days available to conduct prescribed burns (See discussion of annual variability of rainfall below, under this factor). Although prescribed burning is an important management tool, timing of introducing fire into dusky gopher frog habitat should be carefully assessed in order to prevent mortality to the species during its migrations to and from breeding sites (Humphries and Sisson 2012) (USFWS, 2015).

Stressor: Pesticides and herbicides
Exposure:
Response:
Consequence:
Narrative: Pesticides and herbicides commonly used in habitat management pose a threat to amphibians such as the dusky gopher frog, because their permeable eggs and skin readily absorb substances from the surrounding aquatic or terrestrial environment (Duellman and Trueb 1986). Negative effects of commonly used pesticides and herbicides on amphibian larvae include delayed metamorphosis, paralysis, reduced growth rates, and mortality (Bishop 1992, Berrill et al. 1997, Bridges 1999). Sublethal levels of chemical contamination can alter juvenile recruitment in amphibian populations (Bridges and Semlitsch 2000, Rohr et al. 2013). Herbicides 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 frogs (USFWS, 2015).

Recovery

Reclassification Criteria:
1. Six viable metapopulations are documented within blocks of recovery focus areas (described in Section II of this recovery plan) and are widely distributed across the range of the species. The six metapopulations would include a minimum of 12 breeding ponds distributed within the species historic range.

2. Long-term monitoring (at least 10 years) of each metapopulation documents population viability (viability standard to be defined through a recovery task). The 10-year timeframe will allow monitoring recruitment events and other population attributes in a species that has been characterized by highly variable reproductive and survival rates. In each of at least two annual breeding events within a three-year period, a total of 30 egg masses per metapopulation must be documented and natural recruitment must be verified.

3. Breeding and adjacent upland habitats within the six metapopulations are protected longterm through management agreements, public ownership, or other means, in sufficient quantity and quality (to be determined by recovery task) to support growing populations.

4. Studies of the dusky gopher frog's biological and ecological requirements have been completed and measures necessary for recovery discovered during these studies are being implemented and are showing progress.

Recovery Priority Number: 5

Delisting Criteria:
1. Four additional metapopulations (beyond those required for downlisting) are established that exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. Each of these 4 meta-populations is supported by a minimum of 2 breeding ponds (Addresses Factor A and E) (USFWS, 2019)

2. Spatial distribution of the four meta-populations (as defined in Criteria 1) includes one metapopulation in each of the focus area blocks 1, 2 and 3. Additionally, one metapopuation occurs in either Focus Block 4 or 5 (USFWS, 2019).

3. Breeding and adjacent upland habitats within the four additional metapopulations are protected by a conservation mechanism (addresses Factor A, D and E) (USFWS, 2019).

4. The threat of disease is ameliorated to the extent that the species will remain viable into the foreseeable future (addresses Factor C) (USFWS, 2019).

Recovery Actions:
- 1. Protect existing wild dusky gopher frog populations through habitat restoration, management and other conservation techniques.
- 2. Monitor dusky gopher frog populations and their habitat.
- 3. Continue searches for additional dusky gopher frog populations
- 4. Conduct a population and habitat viability analysis (PHVA) and develop the necessary supporting research.
- 5. Formulate and implement guidelines for using translocations to establish dusky gopher frog populations.
- 6. Revise and implement a controlled propagation and reintroduction plan to facilitate use of captive dusky gopher frogs in translocation efforts.
- 7. Develop and distribute public educational and informational materials/programs to solicit and promote voluntary stewardship.
- 8. Review and evaluate recovery progress using the SSA framework (see http://sites.google.com/a/fws.gov/ssa/?pli=1).
- Since 2004, eggs have been removed from the Glen's Pond population, and tadpoles and metamorphic dusky gopher frogs have been raised in cattle tanks and released in Jackson County, Mississippi, at a pond (TNC Pond 1) on a site managed by TNC (Old Fort Bayou Mitigation Bank).

- Silviculture, including timber sales with associated longleaf pine restoration and pine thinnings, is the primary activity on the DNF, the location of Glen's Pond. DNF continues to work with the USFWS, and our state and non-governmental partners, to improve habitat for the frog in the area of Glen's Pond and elsewhere on the Forest.
- In 2002, a pond (New Pond) was constructed at a site on the DNF where one had not previously existed. The Harrison County Soil Conservation Service and the Natural Resources Conservation Service (NRCS) worked with USFWS, MDWFP, DNF, and gopher frog researchers to develop a plan for creating a pond that would provide an additional breeding site near Glen's Pond. In 2012, 10 years after the pond was first completed, it achieved the point where it was considered appropriate dusky gopher frog breeding habitat, and the first dusky gopher frog tadpoles were released there.
- The USFWS, DNF, and our non-governmental partners began working with the developers of a site immediately adjacent to Glen's Pond and the DNF property boundary to restore and protect habitat, even prior to the listing of the species. Coordinated management efforts have included control of invasive vegetation; removal of beds used to plant off-site pine species; and revegetation with longleaf pine trees. Representatives of the development have also permitted DNF to burn this area as a part of the adjacent forest burn unit surrounding Glen's Pond. By burning the whole area as a single unit, the need for a permanent firebreak was avoided, along with potential threats to the frog and its belowground habitat.
- The Nature Conservancy has worked with the USFWS and NRCS to develop a management plan that will improve the longleaf pine habitat at the naturally-occurring dusky gopher frog population supported by Mike's Pond. TNC received funding from NRCS through the Healthy Forest Reserve Program to implement the management plan which includes prescribed burning, restoring an additional pond for potential gopher frog breeding, and planting longleaf pine on the site.
- Due to the paucity of available suitable habitat for the dusky gopher frog, the USFWS worked with our state, Federal, and nongovernmental partners to identify and restore additional upland and wetland habitats to create appropriate translocation sites for the species, in close proximity to each other when possible. After restoration efforts were completed, suitable sites were included in the designation of critical habitat for the dusky gopher frog. After completing habitat assessments of available restored habitat, a site on TNC property, managed as Old Fort Bayou Mitigation Bank, was considered to be in the best condition to support an initial translocation attempt. Tadpoles and metamorphic frogs were released at the site and two breeding events have been verified there.
- For a decade, numerous unsuccessful efforts in captive reproduction were made and the potential founder population was periodically augmented from Glen's Pond. A breakthrough using in vitro fertilization was achieved in 2008, and captive breeding efforts have subsequently occurred at two facilities. Results from the most recent census of dusky gopher frogs in captivity (March, 2014) indicate there are 554 individuals distributed among 16 AZA institutions. The maintenance of initial founder genetic diversity is being achieved through selected pairings to avoid inbreeding.
- The COE owns the Ward Bayou Wildlife Management Area (WBWMA) in Jackson County, Mississippi, a property managed by the MDWFP. The COE, MDWFP, USFWS, and our nongovernmental partners are cooperating on efforts to establish two potential dusky gopher frog breeding ponds on WBWMA. Beginning in 2006, efforts were begun to restore one pond and create an additional pond nearby. Over time, alterations to both ponds have

been necessary to improve their hydrology. Monitoring of the two ponds will continue until such time that the wetlands are determined to be appropriate breeding habitat for dusky gopher frogs and translocations can begin. In conjunction with the work on the two ponds, improvements have been made to the uplands surrounding them.

- The MDWFP has used Section 6 funding provided under the Act in collaboration with the USFWS to benefit the dusky gopher frog by conducting surveys; monitoring the Glen's Pond and Mike's Pond population, as well as other sites; and head-starting tadpoles for, and monitoring, translocation efforts.
- In 2012, through a partnership between Ecological Services and Refuges, the USFWS acquired funding through our own Cooperative Recovery Initiative to work towards establishing dusky gopher frogs on the Mississippi Sandhill Crane National Wildlife Refuge (MSCNWR).
- Gopher tortoises, whose burrows are frequently occupied by gopher frogs of other species, are absent from most of the areas currently occupied by the dusky gopher frogs. As a result, efforts to reestablish gopher tortoises to these areas have been made to improve available belowground habitat for the frogs.
- The Glen's Pond dusky gopher frog breeding site was discovered during surveys conducted in 1988. Ever since that time, searches for additional populations of the frog have been on-going.
- Glen's Pond was discovered to be a gopher frog breeding site on February 3, 1988 (Young et al. 1995). Egg mass and breeding call surveys were conducted at the pond from 1987 through 1996 as the primary means of monitoring the population (Young et al. 1995). Currently, metamorphic dusky gopher frogs captured at the drift fence are marked below the knee with fluorescent VIA tags and all adult gopher frogs are implanted with a Passive Integrated Transponder (PIT) tag (Sisson et al. 2008). Egg mass and call surveys are used in addition to the data collected at the drift fence to monitor the population and collect demographic information. Maintaining the pond water level after a dusky gopher frog breeding event was achieved in 2001 by supplementing the pond with 96,899 gal (366,805 L) of water from water tanker trucks and = 7,133 gal/day (27,000 L/day) of water pumped from underground for 23 days (Seigel et al. 2006). This was attempted again in 2005 for 8 days of 5,831 gal/day (22,073 L/day) using only pumped ground water. Both events resulted in the maintenance of the pond level and allowed larval dusky gopher frogs to reach metamorphosis. The practice of supplementing Glen's Pond with ground water was discontinued following a die-off of dusky gopher frog tadpoles due to disease.
- One-third of the egg masses were collected and hatched in a nearby laboratory. Tadpoles from the eggs were either released back into Mike's Pond (295 tadpoles/approximately 80 days post-hatching) or raised in cattle watering tanks and then released at Mike's Pond (138 metamorphs) or Glen's Pond (389 metamorphs) after metamorphosis (Lee 2010, Pechmann and Tupy 2010). Additionally, progeny were also sent to the Memphis Zoo and the Audubon Zoo (Pechmann and Tupy 2010).
- When breeding has occurred at Glen's Pond and/or Mike's Pond, eggs have been collected from individual clutches for genetic sampling.
- Sawdust Pond is located on the MSCNWR where we have begun a translocation project using funding from the Cooperative Recovery Initiative (See discussion above: Management through Partnerships). In 2015, cattle tanks were setup on the refuge and dusky gopher frog tadpoles from the Glen's Pond population where raised to metamorphosis. By mid-May 2015, more than 250 metamorphic frogs were released at the pond with hundreds more

likely to follow.

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SPECIES ACCOUNT: *Rana sierrae* (Sierra Nevada Yellow-legged Frog)

Species Taxonomic and Listing Information

Commonly-used Acronym: SNYLF

Listing Status: Endangered; June 30, 2014 (79 FR 24255).

Physical Description

The Sierra Nevada yellow-legged frog is a medium-sized frog, measuring on average 40 to 95 millimeters (mm) (1.5 to 3.75 inches [in.]) snout-vent length. Adult coloration is highly variable; individuals tend to have a mix of brown and yellow coloring on their upper body, but they can also be gray, red, or greenish-brown. Most individuals have dark spots or splotches on the dorsal side; yellow or light-orange undersides; yellow or white throats, sometimes with some dark pigmentation; and pale lemon yellow to sun yellow on the undersurface of the hind limbs. Males are slightly smaller than females, and have darker, larger thumb bases; but otherwise, the sexes are indistinguishable. Tadpoles are usually dark brown on their back and faintly yellow on their underside. They have a flattened body shape and can grow up to 90 mm (3.54 in.) in length (78 FR 24471; CDFG 2011).

Taxonomy

The former mountain yellow-legged frog (Rana muscosa) "species complex," treated until recently as a single species, has since been divided into two separate species: the mountain yellow-legged frog (Rana muscosa) and the Sierra Nevada yellow-legged frog (Rana sierrae). This determination is consistent with new molecular (mitochondrial DNA), morphological, habitat, and male advertisement call data that recognize these as two distinct species. However, because the majority of research into these species was performed and published under the umbrella "species complex," which until recently treated Rana muscosa and Rana sierrae as a single species, the majority of the information available about these species is only known at the "species complex" level. Sierra Nevada yellow-legged frogs closely resemble the mountain yellow-legged frog, but can be distinguished by their shorter legs. Adults have dorsolateral folds, although they are not prominent; lack vocal sacs; and have smoother tympana and darker toe tips than the foothill yellow-legged frog (Rana boylii) (78 FR 24471; CDFG 2011).

Historical Range

Sierra Nevada yellow-legged frogs were historically abundant across much of the higher elevations of the Sierra Nevada. The precise historical ranges of the Sierra Nevada yellow-legged frog and the mountain yellow-legged frog are difficult to determine, because projections must be inferred from museum collections that do not reflect systematic surveys; and historic survey information is very limited. That said, historical records indicate that the Sierra Nevada yellow-legged frog ranged from north of the Feather River in Butte and Plumas counties south to the Monarch Divide on the west side of the Sierra Nevada crest in Fresno County. East of the Sierra Nevada crest in California, the historical range of the Sierra Nevada yellow-legged frog extended from areas north of Lake Tahoe, through Mono County (including the Glass Mountains) to Inyo County. The species also occurred at locations within the Carson Range of Nevada, including Mount Rose in Washoe County, and in the vicinity of Lake Tahoe in Douglas County, Nevada (Service 2013). Sierra Nevada yellow-legged frogs occupy the western Sierra Nevada north of the Monarch Divide (in Fresno County) and the eastern Sierra Nevada (east of the crest) in Inyo and Mono counties. The northern DPS of the mountain yellow-legged frog extends in the western Sierra Nevada from south of the Monarch Divide in Fresno County through portions of the Kern River drainage; the southern DPS of the mountain yellow-legged frog occupies the canyons of the Transverse Ranges in southern California. The northern DPS of the mountain yellow-legged frog ranges from the Monarch Divide in Fresno County, southward through the headwaters of the Kern River Watershed. The ranges of the two frog species in the mountain yellow-legged complex therefore meet each other roughly along the Monarch Divide to the north, and along the crest of the Sierra Nevada to the east (78 FR 24471; CDFG 2011).

Current Range

Currently, the mountain yellow-legged frog complex exists in montane regions of the Sierra Nevada of California at elevations ranging from 1,370 to 3,660 meters (m) (4,500 to 12,000 feet [ft.]). Sierra Nevada yellow-legged frogs occupy the western Sierra Nevada north of the Monarch Divide (in Fresno County) and the eastern Sierra Nevada (east of the crest) in Inyo and Mono counties. Researchers have reported disappearances of these species from a large fraction of their historical ranges in the Sierra Nevada, with their distributions currently restricted primarily to publicly managed lands at high elevations, including streams, lakes, ponds, and meadow wetlands in National Forests and National Parks. The most pronounced declines in the mountain yellow-legged frog complex have occurred north of Lake Tahoe in the northernmost 125-kilometer (km) (78-mile [mi.]) portion of the range (Sierra Nevada yellow-legged frog), and south of Sequoia and Kings Canyon National Parks in Tulare County, in the southernmost 50-km (31-mi.) portion, where only a few populations of the northern DPS of the mountain yellow-legged frog remain. Mountain yellow-legged frog populations have persisted in greater density in the National Parks of the Sierra Nevada than in the surrounding U.S. Forest Service (USFS) lands, and the populations that do occur in the National Parks generally exhibit greater abundances than those on USFS lands. Currently, the northern DPS of the mountain yellow-legged frog is discrete from the southern DPS because it is separated from the southern frogs by a 225-km (140-mi.) barrier of unsuitable habitat (78 FR 24471; 79 FR 24255; CDFG 2011).

Critical Habitat Designated

Yes; 8/26/2016.

Legal Description

On September 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

437,929 ha (1,082,147 ac) are designated as critical habitat for the Sierra Nevada yellow-legged frog. This area represents approximately 18 percent of the historical range of the species as estimated by Knapp (unpublished data). All subunits designated as critical habitat are considered occupied (at the subunit level) and include lands within Lassen, Plumas, Sierra, Nevada, Placer, El Dorado, Amador, Calaveras, Alpine, Tuolumne, Mono, Mariposa, Madera, Fresno, and Inyo Counties, California. Three units encompassing 24 subunits are designated as critical habitat for the Sierra Nevada yellowlegged frog.

Unit 1: Sierra Nevada Yellow-Legged Frog Clade 1 Unit 1 represents the northernmost portion of the species' range. It reflects unique ecological features within the range of the species, comprising populations that are stream-based. Unit 1, including all subunits, is an essential component of the entirety of this critical habitat designation due to the unique genetic and geographic distribution this unit encompasses. The frog populations within Clade 1 of the Sierra Nevada yellow-legged frog are at very low numbers and face significant threats from habitat fragmentation. The critical habitat within the unit is necessary to sustain viable populations within Clade 1 of the Sierra Nevada yellow-legged frog, which are at very low abundances. Unit 1 is crucial to the species for range expansion and recovery. Subunit 1A: Morris Lake The Morris Lake subunit consists of approximately 1,079 ha (2,665 ac), and is located in Plumas County, California, approximately 4 km (2.5 mi) northwest of Highway 70. Land ownership within this subunit consists entirely of Federal land within the Plumas National Forest. This subunit is considered to be within the geographical area occupied by the species at the time of listing and contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the Sierra Nevada yellow-legged frog in the Morris Lake subunit may require special management considerations or protection due to the presence of introduced fishes, water diversions and operations, inappropriate grazing activity, timber management and fuels reduction, and recreational activities. Subunit 1B: Bean Creek The Bean Creek subunit consists of approximately 13,523 ha (33,417 ac). It is located in Plumas County, California, approximately 3 km (1.9 mi) south of Highway 70 near the intersection with Caribou Road, and it is bisected on the south end by the Oroville Highway. Land ownership within this subunit consists of approximately 12,464 ha (30,798 ac) of Federal land and 1,060 ha (2,619 ac) of private land. The Bean Creek subunit is located entirely within the boundaries of the Plumas National Forest. This subunit is considered to be within the geographical area occupied by the species at the time of listing and contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the Sierra Nevada yellow-legged frog in the Bean Creek subunit may require special management considerations or protection due to the presence of introduced fishes, inappropriate grazing activity, timber management and fuels reduction, and recreational activities. Subunit 1C: Deanes Valley The Deanes Valley subunit consists of approximately 2,020 ha (4,990 ac) and is located in Plumas County, California, approximately 5.7 km (3.6 mi) south of Buck's Lake Road, 6.4 km (4 mi) east of Big Creek Road, 7.5 km (4.7 mi) west of Quincy-LaPorte Road, and 3.5 km (2.2 mi) north of the Middle Fork Feather River. Land ownership within this subunit consists of approximately 1,962 ha (4,847 ac) of Federal land and 58 ha (143 ac) of private land. The Deanes Valley subunit is located entirely within the boundaries of the Plumas National Forest. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the Sierra Nevada yellow-legged frog in the

Deanes Valley subunit may require special management considerations or protection due to inappropriate grazing activity, timber management and fuels reduction, and recreational activities. Subunit 1D: Slate Creek The Slate Creek subunit consists of approximately 2,688 ha (6,641 ac), and is located in Plumas and Sierra Counties, California, approximately 0.7 km (0.4 mi) east of the town of LaPorte, and 2.5 km (1.6 mi) southwest of the west branch of Canyon Creek. Land ownership within this subunit consists of approximately 2,259 ha (5,581 ac) of Federal land and 429 ha (1,060 ac) of private land. The Slate Creek subunit is located entirely within the boundaries of the Plumas National Forest. This subunit is considered to be within the geographical area occupied by the species at the time of listing and contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the Sierra Nevada yellow-legged frog in the Slate Creek subunit may require special management considerations or protection due to inappropriate grazing activity, timber management and fuels reduction, and recreational activities.

Unit 2: Sierra Nevada Yellow-Legged Frog Clade 2 This unit represents a significant fraction of the Sierra Nevada yellowlegged frog’s range, and it reflects unique ecological features within the range by comprising populations that are both stream- and lake-based. Unit 2, including all subunits, is an essential component of the entirety of this critical habitat designation due to the unique genetic and geographic distribution this unit encompasses. The frog populations within Clade 2 of the Sierra Nevada yellow-legged frog distribution are at very low to intermediate abundance and face significant threats from habitat fragmentation resulting from the introduction of fish. The critical habitat within the unit is necessary to sustain viable populations within Clade 2 of the Sierra Nevada yellow-legged frog, which are at very low to intermediate abundances. Unit 2 is crucial to the species for range expansion and recovery. Subunit 2A: Boulder/Lone Rock Creeks The Boulder/Lone Rock Creeks subunit consists of approximately 4,500 ha (11,119 ac), and is located in Plumas and Lassen Counties, California, between 8 km (5 mi) and 18 km (11.3 mi) west of Highway 395 near the county line along Wingfield Road. Land ownership within this subunit consists of approximately 3,953 ha (9,767 ac) of Federal land and 547 ha (1,352 ac) of private land. Subunit 2A includes Antelope Lake (which receives two creeks as its northwestern headwaters), and these water bodies provide connectivity for both main areas within the subunit. The Boulder/Lone Rock Creeks subunit is located predominantly within the boundaries of the Plumas National Forest, with some area lying within the Lassen National Forest. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the Sierra Nevada yellow-legged frog in the Boulder/Lone Rock Creeks subunit may require special management considerations or protection due to the presence of introduced fishes, water diversions and operations, inappropriate grazing activity, timber management and fuels reduction, and recreational activities. Subunit 2B: Gold Lake The Gold Lake subunit consists of approximately 6,189 ha (15,294 ac), and is located in Plumas and Sierra Counties, California, approximately 8.7 km (5.4 mi) south of Highway 70, and 4.4 km (2.75 mi) north of Highway 49, along Gold Lake Highway to the east. Land ownership within this subunit consists of approximately 5,488 ha (13,561 ac) of Federal land and 702 ha (1,734 ac) of private land. The Gold Lake subunit is located within the Plumas and Tahoe National Forests. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the Sierra Nevada yellow-legged frog in the Gold Lake subunit may require special management considerations or protection due to introduced fishes, inappropriate grazing activity, timber management and fuels reduction, and recreational activities. Subunit 2C: Black Buttes The Black Buttes subunit consists of approximately 55,057 ha (136,049 ac), and spans from Sierra County through Nevada County into Placer County, California. It is 8.5 km (5.3 mi) west of Highway 89, and 3.7 km (2.3 mi) north of the North Fork American River, and is bisected on the south by Highway 80. Land ownership within this subunit consists of approximately 32,649 ha (80,678 ac) of Federal land and 22,408 ha (55,371 ac) of private land. The Black Buttes subunit is located entirely within the boundaries of the Tahoe National Forest. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the Sierra Nevada yellow-legged frog in the Black Buttes subunit may require special management considerations or protection due to the presence of introduced fishes, water diversions and operations, inappropriate grazing activity, timber management and fuels reduction, and recreational activities. Subunit 2D: Five Lakes The Five Lakes subunit consists of approximately 3,758 ha (9,286 ac), and is located in the eastern portion of Placer County, California, approximately 2 km (1.25 mi) west of Highway 89 and 12.3 km (7.7 mi) east of Foresthill Road. Land ownership within this subunit consists of approximately 2,396 ha (5,921 ac) of Federal land and 1,362 ha (3,365 ac) of private land. The Five Lakes subunit is located entirely within the boundaries of the Tahoe National Forest, including area within the Granite Chief Wilderness. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the Sierra Nevada yellow-legged frog in the Five Lakes subunit may require special management considerations or protection due to the presence of introduced fishes, timber management and fuels reduction, and recreational activities. Subunit 2E: Crystal Range The Crystal Range subunit consists of approximately 33,406 ha (82,548 ac), and is located primarily in El Dorado and Placer Counties, California, approximately 3.8 km (2.4 mi) west of Highway 89, bounded on the south by Highway 50, and 7 km (4.4 mi) east of Ice House Road. The Crystal Range subunit includes portions of the Desolation Wilderness. Land ownership within this subunit consists of approximately 31,261 ha (77,249 ac) of Federal land and 2,145 ha (5,299 ac) of private land. The Crystal Range subunit includes areas within the Eldorado and Tahoe National Forests and also the Lake Tahoe Basin Management Unit. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the Sierra Nevada yellow-legged frog in the Crystal Range subunit may require special management considerations or protection due to the presence of introduced fishes, water diversions and operations, inappropriate grazing activity, and recreational activities. Subunit 2F: East Amador The East Amador subunit consists of approximately 43,414 ha (107,278 ac), and is located in Amador, Alpine, and El Dorado Counties, California. The East Amador subunit is roughly bounded on the northwest by Highway 88, and on the southeast by Highway 4. Land ownership within this subunit consists of approximately 40,140 ha (99,188 ac) of Federal land, 56 ha (138 ac) of State land, and 3,218 ha (7,952 ac) of private land. The East Amador subunit includes areas within the Eldorado, Stanislaus, and Humboldt-Toiyabe National Forests, and areas within the Emigrant Wilderness. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the Sierra Nevada yellow-legged frog in the East Amador subunit may require special management considerations or protection due to the presence of introduced fishes, water diversions and operations, inappropriate grazing activity, timber management and fuels reduction, and recreational activities. Subunit 2G: North Stanislaus The North Stanislaus subunit consists of approximately 10,462 ha (25,851 ac), and is located in Alpine, Tuolumne, and Calaveras Counties, California. It is south of the North Fork Mokelumne River, and is bisected by Highway 4, which traverses the unit from southwest to northeast. Land ownership within this subunit consists of approximately 10,445 ha (25,811 ac) of Federal land and 16 ha (41 ac) of private land. The North Stanislaus subunit is located entirely within the boundaries of the Stanislaus National Forest, the Mokelumne Wilderness and CarsonIceberg Wilderness. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the Sierra Nevada yellow-legged frog in the North Stanislaus subunit may require special management considerations or protection due to the presence of introduced fishes, water diversions and operations, inappropriate grazing activity, timber management and fuels reduction, and recreational activities. Subunit 2H: Wells Peak The Wells Peak subunit consists of approximately 11,711 ha (28,939 ac), and is located in Alpine, Mono, and Tuolumne Counties, California, approximately 6.4 km (4 mi) west of Highway 395, and bounded by Highway 108 on the south. Land ownership within this subunit consists of approximately 11,650 ha (28,788 ac) of Federal land and 61 ha (150 ac) of private land. Federal holdings within the Wells Peak subunit are within the Humboldt-Toiyabe and Stanislaus National Forests, and the Carson-Iceberg and Emigrant Wilderness Areas. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the Sierra Nevada yellow-legged frog in the Wells Peak subunit may require special management considerations or protection due to introduced fishes, inappropriate grazing activity, timber management and fuels reduction, and recreational activities. Subunit 2I: Emigrant Yosemite The Emigrant Yosemite subunit consists of approximately 86,161 ha (212,908 ac), and is located in Tuolumne and Mono Counties, California, approximately 11 km (6.9 mi) south of Highway 108 and 7.4 km (4.6 mi) north of Hetch Hetchy Reservoir. Land ownership within this subunit consists of approximately 86,089 ha (212,730 ac) of Federal land, 50 ha (124 ac) of local jurisdiction lands, and 22 ha (54 ac) of private land. The Emigrant Yosemite subunit is predominantly in Yosemite National Park and the Stanislaus and HumboldtToiyabe National Forests, including lands within the Emigrant and Hoover Wilderness Areas. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the Sierra Nevada yellow-legged frog in the Emigrant Yosemite subunit may require special management considerations or protection due to the presence of introduced fishes and inappropriate grazing activity. Subunit 2J: Spiller Lake The Spiller Lake subunit consists of approximately 1,094 ha (2,704 ac), and is located in Tuolumne County, California, approximately 1.2 km (0.75 mi) west of Summit Lake. The Spiller Lake subunit consists entirely of Federal land, all located within Yosemite National Park. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the Sierra Nevada yellow-legged frog in the Spiller Lake subunit may require special management considerations or protection due to fish persistence. Subunit 2K: Virginia Canyon The Virginia Canyon subunit consists of approximately 891 ha (2,203 ac), and is located in Tuolumne County, California, approximately 4.3 km (2.7 mi) southwest of Spiller Lake, and roughly bounded on the east by Return Creek. The Virginia Canyon subunit consists entirely of Federal land, all located within Yosemite National Park. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the Sierra Nevada yellow-legged frog in the Virginia Canyon subunit may require special management considerations or protection due to fish persistence. Subunit 2L: Register Creek The Register Creek subunit consists of approximately 838 ha (2,070 ac), and is located in Tuolumne County, California, approximately 1.2 km (0.75 mi) west of Regulation Creek, with Register Creek intersecting the subunit on the southwest end and running along the eastern portion to the north. The Register Creek subunit consists entirely of Federal land, all located within Yosemite National Park. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the Sierra Nevada yellow-legged frog in the Register Creek subunit may require special management considerations or protection due to fish persistence. Subunit 2M: White Mountain The White Mountain subunit consists of approximately 8,416 ha (20,796 ac), and is located in Tuolumne and Mono Counties, California, approximately 12.4 km (7.75 mi) west of Highway 395, and is intersected on the southeast boundary by Tioga Pass Road (Highway 120). Land ownership within this subunit consists of approximately 8,366 ha (20,674 ac) of Federal land and 49 ha (122 ac) of private land. The White Mountain subunit is predominantly located within Yosemite National Park and Inyo National Forest, with area located within the Hoover Wilderness. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the Sierra Nevada yellow-legged frog in the White Mountain subunit may require special management considerations or protection due to fish persistence. Subunit 2N: Unicorn Peak The Unicorn Peak subunit consists of approximately 2,088 ha (5,160 ac), and is located in Tuolumne County, California, and is intersected from east to west on its northern boundary by Tioga Pass Road

(Highway 120). The Unicorn Peak subunit consists entirely of Federal land, all within Yosemite National Park. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the Sierra Nevada yellow-legged frog in the Unicorn Peak subunit may require special management considerations or protection due to fish persistence.

Unit 3: Sierra Nevada Yellow-Legged Frog Clade 3 This unit represents a significant portion of the species' range, and it reflects a core conservation area comprising the most robust remaining populations at higher densities (closer proximity) across the species' range. Unit 3, including all subunits, is an essential component of the entirety of this critical habitat designation due to the unique genetic and distributional area this unit encompasses. The frog populations within Clade 3 of the Sierra Nevada yellow-legged frog distribution face significant threats from habitat fragmentation. The critical habitat within the Unit is necessary to sustain viable populations within Clade 3 of the Sierra Nevada yellow-legged frog, which are at very low abundances. Unit 3 is crucial to the species for range expansion and recovery. Subunit 3A: Yosemite Central The Yosemite Central subunit consists of approximately 1,408 ha (3,480 ac), and is located in Mariposa County, California, approximately 4 km (2.5 mi) northwest of Tioga Pass Road (Highway 120) in the heart of Yosemite National Park. The Yosemite Central subunit consists entirely of Federal lands within Yosemite National Park. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the Sierra Nevada yellow-legged frog in the Yosemite Central subunit may require special management considerations or protection due to fish persistence. Subunit 3B: Cathedral The Cathedral subunit consists of approximately 38,784 ha (95,837 ac), and is located in Mariposa, Madera, Mono, and Tuolumne Counties, California, approximately 15.6 km (9.75 mi) west of Highway 395 and 9.4 km (5.9 mi) south of Highway 120. The Cathedral subunit consists entirely of Federal land, including lands in Yosemite National Park, the Inyo National Forest, and an area within the Ansel Adams Wilderness. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the Sierra Nevada yellow-legged frog in the Cathedral subunit may require special management considerations or protection due to the presence of introduced fishes and inappropriate grazing activity. Subunit 3C: Minarets The Minarets subunit consists of approximately 3,090 ha (7,636 ac), and is located in Madera County, California, approximately 5.4 km (3.4 mi) southwest of Highway 203. The Minarets subunit consists entirely of Federal land located within the Inyo National Forest. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the Sierra Nevada yellow-legged frog in the Minarets subunit may require special management considerations or protection due to the presence of introduced fishes and recreational activities. Subunit 3D: Mono Creek The Mono Creek subunit consists of approximately 18,481 ha (45,666 ac), and is located in Fresno and Inyo Counties, California, approximately 16 km (10 mi) southwest of Highway 395. The Mono Creek subunit consists entirely of Federal land located within the Sierra and Inyo National Forests, including area within the John Muir Wilderness. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the Sierra Nevada yellow-legged frog in the Mono Creek subunit may require special management considerations or protection due to the presence of introduced fishes, inappropriate grazing activity, and recreational activities. Subunit 3E: Evolution/Leconte The Evolution/Leconte subunit consists of approximately 87,136 ha (215,318 ac), and is located in Fresno and Inyo Counties, California, approximately 12.5 km (7.8 mi) southwest of Highway 395. Land ownership within this subunit consists of approximately 86,968 ha (214,903 ac) of Federal land, 81 ha (200 ac) of local jurisdictional lands, and 87 ha (215 ac) of private land. The Evolution/Leconte subunit is predominantly within the Sierra and Inyo National Forests, including area within the John Muir Wilderness, and Kings Canyon National Park. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the Sierra Nevada yellow-legged frog in the Evolution/Leconte subunit may require special management considerations or protection due to the presence of introduced fishes and inappropriate grazing activity. Subunit 3F: Pothole Lakes The Pothole Lakes subunit consists of approximately 1,736 ha (4,289 ac), and is located in Inyo County, California, approximately 13.1 km (8.2 mi) west of Highway 395. Land ownership within this subunit consists of approximately 1,735 ha (4,286 ac) of Federal land and 1 ha (2 ac) of private land. The Pothole Lakes subunit is almost entirely located within the Inyo National Forest. This subunit is considered to be within the geographical area occupied by the species at the time of listing, and it contains the physical or biological features essential to the conservation of the species, is currently functional habitat sustaining frogs, and is needed to provide for core surviving populations and their unique genetic heritage. The physical or biological features essential to the conservation of the Sierra Nevada yellow-legged frog in the Pothole Lakes subunit may require special management considerations or protection due to the presence of introduced fishes and recreational activities.

Primary Constituent Elements/Physical or Biological Features

Critical habitat units are designated for Lassen, Plumas, Sierra, Nevada, Placer, El Dorado, Amador, Alpine, Calaveras, 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 Sierra Nevada yellow-legged frog consist of:

(i) Aquatic habitat for breeding and rearing. Habitat that consists of permanent water bodies, or those that are either hydrologically connected with, or close to, permanent water bodies, including, but not limited to, lakes, streams, rivers, tarns, perennial creeks (or permanent plunge pools within intermittent creeks), pools (such as a body of impounded water contained above a natural dam), and other forms of aquatic habitat. This habitat must: (A) For lakes, be of sufficient depth not to freeze solid (to the bottom) during the winter (no less than 1.7 meters (m) (5.6 feet (ft)), but generally greater than 2.5 m (8.2 ft), and optimally 5 m (16.4 ft) or deeper (unless some other refuge from freezing is available)). (B) Maintain a natural flow pattern, including periodic flooding, and have functional community dynamics in order to provide sufficient productivity and a prey base to support the growth and development of rearing tadpoles and metamorphs. (C) Be free of introduced predators. (D) Maintain water during the entire tadpole growth phase (a minimum of 2 years). During periods of drought, these breeding sites may not hold water long enough for individuals to complete metamorphosis, but they may still be considered essential breeding habitat if they provide sufficient habitat in most years to foster recruitment within the reproductive lifespan of individual adult frogs. (E) Contain: (1) Bank and pool substrates consisting of varying percentages of soil or silt, sand, gravel, cobble, rock, and boulders (for basking and cover); (2) Shallower microhabitat with solar exposure to warm lake areas and to foster primary productivity of the food web; (3) Open gravel banks and rocks or other structures projecting above or just beneath the surface of the water for adult sunning posts; (4) Aquatic refugia, including pools with bank overhangs, downfall logs or branches, or rocks and vegetation to provide cover from predators; and (5) Sufficient food resources to provide for tadpole growth and development.

(ii) Aquatic nonbreeding habitat (including overwintering habitat). This habitat may contain the same characteristics as aquatic breeding and rearing habitat (often at the same locale), and may include lakes, ponds, tarns, streams, rivers, creeks, plunge pools within intermittent creeks, seeps, and springs that may not hold water long enough for the species to complete its aquatic life cycle. This habitat provides for shelter, foraging, predator avoidance, and aquatic dispersal of juvenile and adult mountain yellow-legged frogs. Aquatic nonbreeding habitat contains: (A) Bank and pool substrates consisting of varying percentages of soil or silt, sand, gravel, cobble, rock, and boulders (for basking and cover); (B) Open gravel banks and rocks projecting above or just beneath the surface of the water for adult sunning posts; (C) Aquatic refugia, including pools with bank overhangs, downfall logs or branches, or rocks and vegetation to provide cover from predators; (D) Sufficient food resources to support juvenile and adult foraging; (E) Overwintering refugia, where thermal properties of the microhabitat protect hibernating life stages from winter freezing, such as crevices or holes within bedrock, in and near shore; and/or (F) Streams, stream reaches, or wet meadow habitats that can function as corridors for movement between aquatic habitats used as breeding or foraging sites.

(iii) Upland areas. (A) Upland areas adjacent to or surrounding breeding and nonbreeding aquatic habitat that provide area for feeding and movement by mountain yellow-legged frogs. (1) For stream habitats, this area extends 25 m (82 ft) from the bank or shoreline. (2) In areas that contain riparian habitat and upland vegetation (for example, mixed conifer, ponderosa pine, montane conifer, and montane riparian woodlands), the canopy overstory should be sufficiently thin (generally not to exceed 85 percent) to allow sunlight to reach the aquatic habitat and thereby provide basking areas for the species. (3) For areas between proximate (within 300 m (984 ft)) water bodies (typical of some high mountain lake habitats), the upland area extends from the bank or shoreline between such water bodies. (4) Within mesic habitats such as lake and meadow systems, the entire area of physically contiguous or proximate habitat is suitable for dispersal and foraging. (B) Upland areas (catchments) adjacent to and surrounding both breeding and nonbreeding aquatic habitat that provide for the natural hydrologic regime (water quantity) of aquatic habitats. These upland areas should also allow for the maintenance of sufficient water quality to provide for the various life stages of the frog 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 Sierra Nevada yellow-legged frog and northern DPS of the mountain yellow-legged frog may require special management considerations or protection to reduce the following threats: The persistence of introduced trout populations in essential habitat; the risks related to the spread of pathogens; the effects from water withdrawals and diversions; impacts associated with timber harvest and fuels reduction activities; impacts associated with inappropriate livestock grazing; and intensive use by recreationists, including packstock camping and grazing.

Conservation actions that could ameliorate the threats described above include (but are not limited to) nonnative fish eradication; installation of fish barriers; modifications to fish stocking practices in certain water bodies; physical habitat restoration; and responsible management practices covering potentially incompatible activities, such as timber harvest and fuels management, water supply development and management, inappropriate livestock grazing, packstock grazing, and other recreational uses. These management practices will protect the PCEs for the mountain yellow-legged frog by reducing the stressors currently affecting population viability. Additionally, management of critical habitat lands will help maintain the underlying habitat quality, foster recovery, and sustain populations currently in decline.

Life History

Food/Nutrient Resources

Food Source

Larvae: Algae, diatoms, detritus, conspecific eggs, and adult/tadpole carcasses (78 FR 24471; CDFG 2011).

Juvenile: Algae, diatoms, detritus, conspecific eggs, and adult/tadpole carcasses (78 FR 24471; CDFG 2011).

Adult: Terrestrial insects, adult aquatic insects, benthic macroinvertebrates, and amphibian tadpoles and adults (78 FR 24471; CDFG 2011).

Competition

Larvae: None

Juvenile: None

Adult: Because of their need to overwinter underwater, Sierra Nevada yellow-legged frogs and introduced (stocked) trout are both typically restricted to large, deep water bodies. However, the majority of lentic water bodies in the Sierra Nevada are relatively small and shallow. Therefore, the critical habitat necessary for both frogs and trout to overwinter is relatively uncommon. With the widespread introduction of nonnative trout, nearly all large, deep lakes that could provide suitable overwintering habitat for frogs are now occupied by introduced trout. In addition to their role as predators of Sierra Nevada yellow-legged frogs, trout are competitors for the same invertebrate species that frogs rely on for food (e.g., terrestrial invertebrates and adult stages of aquatic insects). In Sierra Nevada lakes, large, conspicuous invertebrate taxa are rare or absent in trout-containing lakes, but are relatively common in lakes without trout. The direct impacts of trout predation on invertebrates can have a negative effect on frogs via competition for invertebrate prey; and can alter lake nutrient cycles, resulting in negative impacts to frogs and other native species (CDFG 2011).

Food/Nutrient Narrative

Larvae: Sierra Nevada yellow-legged frog tadpoles maintain a relatively high body temperature by selecting warmer microhabitats. During winter, tadpoles remain in warmer water below the thermocline (the transition layer between thermally stratified water). After spring overturn (thaw and thermal mixing of the water), they behaviorally modulate their body temperature by moving to shallow, near-shore water when warmer days raise surface water temperatures. During the late afternoon and evening, Sierra Nevada yellow-legged frogs retreat to offshore waters that are less subject to night cooling (78 FR 24471).

Juvenile: Sierra Nevada yellow-legged frogs are omnivorous, feeding as tadpoles on algae, diatoms, and detritus. Tadpoles forage for prey at the bottoms of lakes, ponds, and streams, in shallow waters. During winter, tadpoles remain in warmer water below the thermocline; in the spring, when warmer days raise surface water temperatures, they move to shallow, near-shore water, retreating during the late afternoon and evening to offshore waters that are less subject to night cooling (78 FR 24471; CDFG 2011). Tadpoles may take more than 1 year, and often require 2 to 4 years, to reach metamorphosis (transformation from tadpoles to frogs), depending on local climate conditions and site-specific variables (78 FR 24471; CDFG 2011).

Adult: Sierra Nevada yellow-legged frogs are omnivorous; adult diet consists of terrestrial and aquatic insects and macro invertebrates, other amphibians, and the occasional cannibalism of eggs and tadpole/adult carcasses. Adults forage for prey at the bottoms of lakes, ponds, and streams; in shallow waters; and onshore.As adults, frogs maximize body temperatures during a majority of the day by basking in the sun, moving between water and land, and concentrating in the warmer shallows along the shoreline. As temperatures decrease in the fall, frogs become less active and move to overwintering habitats (78 FR 24471; CDFG 2011).With the widespread introduction of nonnative trout, nearly all large, deep lakes that could provide suitable overwintering habitat for frogs are now occupied by introduced trout. In addition to their role as predators of Sierra Nevada yellow-legged frogs, trout are competitors for the same invertebrate species that frogs rely on for food. The direct impacts of trout predation on invertebrates can have a negative effect on frogs via competition for invertebrate prey; and can alter lake nutrient cycles, resulting in negative impacts to frogs and other native species (CDFG 2011).

Reproductive Strategy

Adult: Demersal spawning.

Lifespan

Adult: The longevity of adults is unknown, but adult survivorship from year to year is very high under normal circumstances. Sierra Nevada yellow-legged frogs are presumed to be long-lived amphibians (78 FR 24471; CDFG 2011).

Dependency on Other Individuals or Species

Adult: None

Breeding Season

Adult: Adults emerge from overwintering sites at spring thaw or snowmelt and commence breeding soon thereafter—between April and May at lower elevations and progressively later (June and July) at higher elevations (CDFG 2011). Breeding timing can vary year-to-year based on annual snowfall.

Key Resources Needed for Breeding

Adult: Lake or in-stream pool depth is an important attribute in defining habitat suitability for Sierra Nevada yellow-legged frogs. Because tadpoles must overwinter multiple years before metamorphosis, successful breeding sites are located in (or connected to) lakes, ponds, and in-stream pools and ponds that do not dry out in the summer, and also are deep enough that they do not completely freeze or become oxygen-depleted (anoxic) in winter (78 FR 24471).

Other Reproductive Information

Adult: Adult Sierra Nevada yellow-legged frogs breed in the shallows of ponds and lakes or in inlet streams. Adults emerge from overwintering sites immediately following snowmelt, and will even move over ice to reach breeding sites. Sierra Nevada yellow-legged frogs deposit their eggs underwater in clusters, attaching them to rocks, gravel, or vegetation, or depositing them under banks. Sierra Nevada yellow-legged frogs deposit their eggs in globular clumps, which are often somewhat flattened and roughly 2.5 to 5 centimeters (cm) (1 to 2 in.) in diameter. Eggs have three firm, jelly-like, transparent envelopes surrounding a grey-tan or black vitelline (egg yolk) capsule. Egg development is temperature-dependent (78 FR 24471; CDFG 2011).

Reproduction Narrative

Adult: Adults emerge from overwintering sites at spring thaw or snowmelt and commence breeding soon thereafter—generally between April and May at lower elevations and progressively later (June and July) at higher elevations (CDFG 2011). Eggs are deposited underwater in the shallows of ponds and lakes or in inlet streams in clusters, and are attached to rocks, gravel, or vegetation, or deposited under banks. Because tadpoles must overwinter multiple years before metamorphosis, successful breeding sites are located in (or connected to) lakes, and ponds, and in-stream pools that do not dry out in the summer, and also are deep enough that they do not completely freeze or become oxygen-depleted (anoxic) in winter. The eggs are deposited in globular clumps, which are often somewhat flattened and roughly 2.5 to 5 cm (1 to 2 in.) in diameter. Clutch size varies from 15 to 350 eggs per egg mass. Egg hatching time ranges from 16 to 21 days at temperatures of 5 to 13.5 degrees Celsius (41 to 56 degrees Fahrenheit). The time required to reach reproductive maturity in Sierra Nevada yellow-legged frogs is thought to vary between 3 and 4 years post-metamorphosis. In combination with the extended amount of time as a tadpole before metamorphosis, it may take 5 to 8 years for Sierra Nevada yellow-legged frogs to begin reproducing (78 FR 24471; CDFG 2011). The longevity of adults is unknown, but adult survivorship from year to year is very high under normal circumstances. Sierra Nevada yellow-legged frogs are presumed to be long-lived amphibians (78 FR 24471; CDFG 2011).

Habitat Type

Larvae: See Adult life history.

Juvenile: See Adult life history.

Adult: Montane regions of the Sierra Nevada of California; lakes, ponds, marshes, meadows, and streams at elevations ranging from 1,370 to 3,660 m (4,500 to 12,000 ft.) (78 FR 24471; CDFG 2011).

Habitat Vegetation or Surface Water Classification

Larvae: See Adult life history.

Juvenile: See Adult life history.

Adult: Lakes, ponds, tarns (small steep-banked mountain lakes or pools), streams, marshes, and meadows (78 FR 24471; CDFG 2011).

Dependencies on Specific Environmental Elements

Larvae: See Adult life history.

Juvenile: See Adult life history.

Adult: Sierra Nevada yellow-legged frogs are highly aquatic; they are generally not found more than 1 m (3.3 ft.) from water (78 FR 24471; CDFG 2011). Adults typically are found sitting on rocks along the shoreline, usually where there is little or no vegetation. Although Sierra Nevada yellow-legged frogs may use a variety of shoreline habitats, both tadpoles and adults are less common at shorelines that drop abruptly to a depth of 60 cm (2 ft.) than at open shorelines that gently slope up to shallow waters of only 5 to 8 cm (2 to 3 in) in depth (78 FR 24471). At lower elevations within their historical range, these species are known to be associated with rocky streambeds and wet meadows surrounded by coniferous forest. Streams used by adults vary from streams having high gradients and numerous pools, rapids, and small waterfalls; to streams with low gradients and slow flows, marshy edges, and sod banks. Aquatic substrates vary from bedrock to fine sand, rubble (rock fragments), and boulders. Sierra Nevada yellow-legged frogs to be appear absent from the smallest creeks, probably because these creeks have insufficient depth for adequate refuge and overwintering habitat. Sierra Nevada yellow-legged frogs do use stream habitats, especially the remnant populations in the northern part of their range. At higher elevations, these species occupy lakes, ponds, tarns (small steep banked mountain lakes or pools), and streams. Sierra Nevada yellow-legged frogs in the Sierra Nevada are most abundant in high-elevation lakes and slow-moving portions of streams. The borders of alpine (above the tree line) lakes and mountain meadow streams used by mountain yellow-legged frogs are frequently grassy or muddy. This differs from the sandy or rocky shores inhabited by Sierra Nevada yellow-legged frogs in lower elevation streams. Both adult and tadpole Sierra Nevada yellow-legged frogs overwinter for up to 9 months in the bottoms of lakes that are at least 1.7 m (5.6 ft.) deep; however, overwinter survival may be greater in lakes that are at least 2.5 m (8.2 ft.) deep (78 FR 24471). Where water depths range from 0.2 m (0.7 ft.) to 1.5 m (5 ft.), the availability of rock crevices, holes, and ledges near shore offer protection to overwintering frogs when water bodies freeze over completely (78 FR 24471).

Geographic or Habitat Restraints or Barriers

Larvae: See Adult life history.

Juvenile: See Adult life history.

Adult: Highly aquatic.

Spatial Arrangements of the Population

Larvae: See Adult life history.

Juvenile: See Adult life history.

Adult: Clumped

Environmental Specificity

Larvae: See Adult life history.

Juvenile: See Adult life history.

Adult: Narrow

Tolerance Ranges/Thresholds

Larvae: See Adult life history.

Juvenile: See Adult life history.

Adult: During the active season, post-metamorphic frogs maximize body temperatures during a majority of the day by basking in the sun, moving between water and land (depending on which is warmer), and concentrating in the warmer shallows along the shoreline. As temperatures decrease in the fall, frogs become less active and move to overwintering habitats. In years with exceptionally heavy snow packs, frog populations at high elevations may be active for only about 90 days during the warmest part of the summer (78 FR 24471; CDFG 2011).

Site Fidelity

Larvae: See Adult life history.

Juvenile: See Adult life history.

Adult: High

Dependency on Other Individuals or Species for Habitat

Larvae: See Adult life history.

Juvenile: See Adult life history.

Adult: None

Habitat Narrative

Larvae: See Adult life history.

Juvenile: See Adult life history.

Adult: Sierra Nevada yellow-legged frogs currently exist in montane regions of the Sierra Nevada of California in lakes, ponds, marshes, meadows, and streams at elevations ranging from 1,370 to 3,660 m (4,500 to 12,000 ft.). Sierra Nevada yellow-legged frogs are highly aquatic, are generally not found more than 1 m (3.3 ft.) from water (78 FR 24471; CDFG 2011), and display strong site fidelity, returning to the same overwintering and summer habitats from year to year (78 FR 24471).Both adult and tadpole Sierra Nevada yellow-legged frogs overwinter for up to 9 months in the bottoms of lakes, ponds, and in-stream pools that are at least 1.7 m (5.6 ft.) deep; however, overwinter survival may be greater in lakes that are at least 2.5 m (8.2 ft.) deep (78 FR 24471). Where water depths range from 0.2 m (0.7 ft.) to 1.5 m (5 ft.), the availability of rock crevices, holes, and ledges near shore offer protection to overwintering frogs when water bodies freeze over completely (78 FR 24471).

Dispersal/Migration

Motility/Mobility

Juvenile: See Adult life history.

Adult: Low due to dependence on aquatic habitats.

Dispersal

Juvenile: See Adult life history.

Adult: Low

Dependency on Other Individuals or Species for Dispersal

Juvenile: See Adult life history.

Adult: None

Dispersal/Migration Narrative

Juvenile: See Adult life history.

Adult: Sierra Nevada yellow-legged frogs are highly aquatic and generally not found more than 1 m (3.3 ft.) from water. Movements are typically localized, consisting of dispersal between selected breeding, feeding, and overwintering habitats during the course of a year, but can also lead to the re-colonization of sites where frogs have been extirpated previously. In aquatic habitats of high mountain lakes, Sierra Nevada yellow-legged frog adults typically move only a few hundred m (few hundred yards), but single-season distances of up to 3.3 km (2.05 mi.) have been recorded along streams (78 FR 24471). Regular overland movements of more than 66 m (217 ft.) have been recorded, with individuals ranging as far 400 m (1,300 ft.) from water. During the overwintering period, adults have been observed along stream habitats more than 22 m (71 ft.) from the water (78 FR 24471; CDFG 2011).Regionally, Sierra Nevada yellow-legged frogs are thought to exhibit a metapopulation structure; metapopulations are spatially separated population subunits within migratory distance of one another, allowing individuals to interbreed among subunits and populations to become reestablished if they are extirpated (78 FR 24471).

Additional Life History Information

Juvenile: See Adult life history.

Adult: The travel of adults through aquatic and dry land habitats also allows the re-colonization of sites from which frog populations were extirpated. For example, following the disappearance or active removal of nonnative trout from lakes, frogs rapidly recolonized these sites from nearby source populations (CDFG 2011).

Population Information and Trends

Population Trends:

Decreasing

Species Trends:

Decreasing

Population Growth Rate:

Declining

Number of Populations:

California Department of Fish and Game (now California Department of Fish and Wildlife determined there are 1,199 occupied sites (defined as a discrete pond, lake, reservoir, meadow, marsh, spring, or stream) across 94 USGS HUC12 watersheds (CDFG 2011). Remaining populations are generally very small; estimates range from losses of between 69 to 93 percent of historically occupied habitat (79 FR 24255)

Population Size:

Population size estimates range from 1,000 to 10,000 individuals (NatureServe 2015).

Resistance to Disease:

Low

Adaptability:

Low

Additional Population-level Information:

Range-wide, declines of populations of the mountain yellow-legged frog complex were estimated at around one-half of historical populations by the end of the 1980s. Between 1988 and 1991, a resurvey of sites known historically (surveys from 1955 through 1979) to support the mountain yellow-legged frog complex detected frogs at 19.4 percent of historical sites. During 2002, a resurvey of 302 water bodies known to be occupied by the mountain yellow-legged frog complex between 1995 and 1997, and 744 sites where frogs were not previously detected, found frogs at 59 percent of the previously occupied sites, whereas 8 percent of previously unoccupied sites were colonized. These data suggest an extirpation rate five to six times higher than the colonization rate in this study area.Documented extirpations appear to occur nonrandomly across the landscape, are typically spatially clumped, and involve the disappearance of all or nearly all of the mountain yellow-legged frog complex populations in a watershed. CDFW assessed data from sites where multiple surveys were completed after 1995 (at least 5 years apart), and found that the Sierra Nevada yellow-legged frog was not detected at 45 percent of sites where they previously had been confirmed.To summarize population trends over the available historical record, estimates range from losses between 69 to 93 percent of Sierra Nevada yellow-legged frog populations. Range-wide reduction has diminished the number of watersheds that support the mountain yellow-legged frog complex—at a conservative estimate of 44 percent for Sierra Nevada yellow-legged frogs and at least 59 percent in the case of northern DPS of the mountain yellow-legged frogs, to as high as 97 percent of watersheds for the mountain yellow-legged frog complex across the Sierra Nevada. Remaining populations are much smaller than historical norms, and the density of populations per watershed has declined substantially; as a result, many watersheds currently support single metapopulations at low abundances.CDFW used historical localities from museum records covering 1899 through 1994, updated with recent locality information from additional survey data (1995 through 2010), and failed to detect any extant frog populations (within 1 km [0.63 mi.]), a metric used to capture interbreeding individuals in metapopulations) at 220 of 318 historical Sierra Nevada yellow-legged frog localities. This represents an estimated loss of 69 percent of Sierra Nevada yellow-legged frog metapopulations from historical occurrences.In the Sierra Nevada, 44 percent of watersheds historically used by Sierra Nevada yellow-legged frogs no longer support extant populations. However, this watershed-level survey methodology is not a good indicator of population changes, because a watershed is counted as recently occupied if a single individual (at any life stage) is observed in the entire watershed, even though several individual populations may have been lost. Therefore, these surveys likely underestimate population declines. Many watersheds support only a single extant metapopulation, which occupies one to several adjacent water bodies (79 FR 24255).

Population Narrative:

Monitoring efforts and research studies have documented substantial declines of populations of the mountain yellow-legged frog complex in the Sierra Nevada. The number of extant populations has declined greatly over the last few decades. Remaining populations are patchily scattered throughout the historical range. Documented extirpations appear to occur nonrandomly across the landscape, are typically spatially clumped, and involve the disappearance of all or nearly all of the populations of the mountain yellow-legged frog complex in a watershed. Over the available historical record, estimated losses range from 69 to 93 percent. Range-wide reduction has diminished the number of watersheds that support mountain yellow-legged frogs (R. sierrae), at a conservative estimate of 59 percent. Remaining populations are much smaller than historical norms, and the density of populations per watershed has declined substantially; as a result, many watersheds currently support single metapopulations at low abundances. Remaining populations are generally very small, and available information indicates that the rates of population decline have not abated, and they have likely accelerated during the 1990s into the 2000s (79 FR 24255). Extensive surveys between 1995 and 2005 yielded only 11 occupied sites, and population size estimates range from 1,000 to 10,000 individuals (NatureServe 2015).

Threats and Stressors

Stressor: Habitat destruction (recreation)
Exposure: Direct/indirect.
Response: Loss/degradation of habitat.

Consequence: Degradation of habitat, reduction of quality/quantity of breeding/foraging/upland habitat, reduction in population numbers, decreased reproductive success, increased genetic effects of population bottleneck, increased susceptibility to mortality/extirpation.
Narrative: Recreational foot traffic in naturally stressed Sierra Nevada ecosystems like riparian areas tramples the vegetation, compacts the soils, and can physically damage the streambanks. Hiking, horse, bicycle, or off-highway motor vehicle trails compact soils in riparian habitat, and can lower the water table and cause increased erosion. The recreational activity of anglers at high mountain lakes can be locally intense in the Sierra Nevada, with most regions reporting a level of use greater than the fragile lakeshore environments can withstand. Recreational activities are the fastest growing use of National Forests. Therefore, their impacts on the Sierra Nevada yellow-legged frog complex are likely to continue and to increase. Currently, recreational activities are considered a threat of low significance to the species' habitat overall (78 FR 24471).

Stressor: Habitat destruction (habitat modification due to introduction of trout to historically fishless areas).
Exposure: Direct/indirect.
Response: Loss/degradation of habitat.
Consequence: Degradation of habitat, reduction of quality/quantity of breeding/foraging/upland habitat, reduction in population numbers, decreased reproductive success, increased genetic effects of population bottleneck, increased susceptibility to mortality/extirpation.
Narrative: Trout both compete for limited resources and directly prey on Sierra Nevada yellow-legged frog tadpoles and adults. These fish decimate frog populations through competition and predation, leading to the isolation of populations and preventing recolonization by frogs. Fundamentally, this has prevented deeper lakes from serving as Sierra Nevada yellow-legged frog habitat at a landscape scale. Introduced trout have also negatively impacted Sierra Nevada yellow-legged frogs over much of the Sierra Nevada because fish eat aquatic flora and fauna, including amphibians and invertebrates—the same resource base that sustains the growth of both frogs and trout.Although most of the impacts occurred historically, the impact on the biogeographic (population/metapopulation) integrity of the species will be long-lasting. Currently, habitat degradation and fragmentation by fish is considered a highly significant and prevalent threat to the persistence and recovery of the species (78 FR 24471).

Stressor: Habitat destruction (dams and water diversions).
Exposure: Indirect
Response: Loss/degradation of habitat.
Consequence: Degradation of habitat, reduction of quality/quantity of breeding/foraging/upland habitat, reduction in population numbers, decreased reproductive success, increased genetic effects of population bottleneck, increased susceptibility to mortality/extirpation.
Narrative: Numerous reservoirs, dams, and water diversions have been constructed within the ranges of the Sierra Nevada yellow-legged frog complex and altered aquatic habitats in the Sierra Nevada. The combination of these features has reduced habitat suitability within the range of the species by creating migration barriers and altering local hydrology. This stressor causes considerable habitat fragmentation and direct habitat loss in those areas where water projects were constructed and are operating. Dams alter the temperature and sediment load of the rivers they impound. Dams, water diversions, and their associated structures also alter the natural flow regime with unseasonal and fluctuating releases of water. These features may create habitat conditions unsuitable for native amphibians both upstream and downstream of dams, and they may act as barriers to movement by dispersing juvenile and migrating adult amphibians.Where

dams act as barriers to Sierra Nevada yellow-legged frog movement, they effectively prevent genetic exchange between populations and the recolonization of vacant sites. Water diversions may remove water from Sierra Nevada yellow-legged frog habitat and adversely impact breeding success and adult survivorship. This results in physical reduction in habitat area and potentially lowers water levels to the extent that the entire water column freezes in the winter, thereby removing aquatic habitat altogether. Given the amount of water development in the historical ranges of Sierra Nevada yellow-legged frogs, these factors likely have contributed to population declines; and ongoing management and habitat fragmentation will continue to pose a risk to the species. The magnitude of such impacts would increase if long droughts become more frequent in the future, or if increasing diversions and storage facilities are constructed and implemented to meet growing needs for water and power. Currently, dams and water diversions are considered a moderate, prevalent threat to the persistence and recovery of the species (78 FR 24471).

Stressor: Habitat destruction (livestock use/grazing).
Exposure: Indirect
Response: Loss/degradation of habitat.
Consequence: Degradation of habitat, reduction of quality/quantity of breeding/foraging/upland habitat, reduction in population numbers, decreased reproductive success, increased genetic effects of population bottleneck, increased susceptibility to mortality/extirpation.
Narrative: Grazing reduces the suitability of habitat for Sierra Nevada yellow-legged frogs by reducing its capability to sustain frogs and facilitate dispersal and migration, especially in stream areas. The impact of this stressor to Sierra Nevada yellow-legged frogs is ongoing, but of relatively low importance as a limiting factor on extant populations. Although this stressor may have played a greater role historically, leading in part to range-wide reduction of the species, the geographic extent of livestock grazing activity in current Sierra Nevada yellow-legged frog habitat does not encompass the entire range of the species.For Sierra Nevada yellow-legged frogs, livestock grazing activity is likely a minor prevalent threat to currently extant populations, although in certain areas it may exacerbate habitat fragmentation already facilitated by the introduction of trout. This threat is likely more one of historical significance. Although it may be a factor in certain allotments with active grazing and extant populations, range-wide it is likely not a significant risk factor, because many populations persist outside of actively grazed areas (78 FR 24471).

Stressor: Habitat destruction (packstock use).
Exposure: Indirect
Response: Loss/degradation of habitat.
Consequence: Degradation of habitat, reduction of quality/quantity of breeding/foraging/upland habitat, reduction in population numbers, decreased reproductive success, increased genetic effects of population bottleneck, increased susceptibility to mortality/extirpation.
Narrative: Packstock grazing is the only grazing currently permitted in the National Parks of the Sierra Nevada. Use of packstock in the Sierra Nevada has increased since World War II. Packstock use is likely a threat of low significance to Sierra Nevada yellow-legged frogs at the current time, except on a limited, site-specific basis. As California's human population increases, the impact of recreational activities, including packstock use and riding in the Sierra Nevada, are projected to increase. This activity may pose a risk to some remnant populations of frogs and, in certain circumstances, a hindrance to recovery (78 FR 24471).

Stressor: Habitat destruction (roads and timber harvest).
Exposure: Indirect
Response: Loss/degradation of habitat.
Consequence: Degradation of habitat, reduction of quality/quantity of breeding/foraging/upland habitat, reduction in population numbers, decreased reproductive success, increased genetic effects of population bottleneck, increased susceptibility to mortality/extirpation.
Narrative: Activities that alter the terrestrial environment (such as road construction and timber harvest) may impact amphibian populations in the Sierra Nevada. These impacts are understandably in proportion to the magnitude of the alteration to the environment. Road construction and timber harvest were likely of greater significance historically, and may have acted to reduce the species' range prior to the more recent detailed studies and systematic monitoring that have quantified and documented these losses. Timber harvest activities remove vegetation and cause ground disturbance and compaction, making the ground more susceptible to erosion, which could potentially damage frog breeding habitat downstream; and may alter the annual hydrograph, possibly lowering the water table. This erosion increases siltation downstream that could potentially damage Sierra Nevada yellow-legged frog breeding habitat and contribute to habitat fragmentation, limiting amphibian movement.Currently, most of the Sierra Nevada yellow-legged frog populations occur in National Parks or designated wilderness areas where timber is not harvested. Other Sierra Nevada yellow-legged frog populations outside these areas are above the timberline, so timber harvest activity is not expected to affect the majority of extant Sierra Nevada yellow-legged frog populations. There remain some Sierra Nevada yellow-legged frog populations in areas where timber harvests occur or may occur in the future. Roads also exist within the range of the Sierra Nevada yellow-legged frog, and more may be constructed. However, neither of these factors has been implicated as an important contributor to the decline of this species. It is likely a minor prevalent threat to Sierra Nevada yellow-legged frogs factored across the range of the species (78 FR 24471).

Stressor: Habitat destruction (fire and fire management activities).
Exposure: Direct/indirect.
Response: Loss/degradation of habitat; mortality.
Consequence: Degradation of habitat, reduction of quality/quantity of breeding/foraging/upland habitat, reduction in population numbers, decreased reproductive success, increased genetic effects of population bottleneck, increased susceptibility to mortality/extirpation.
Narrative: Sierra Nevada yellow-legged frogs are generally found at high elevations in wilderness areas and National Parks where vegetation is sparse and fire suppression activities are infrequently implemented. Where such fire management activities occur, potential impacts that may result include habitat degradation through water drafting (taking of water) from occupied ponds and lakes; erosion and siltation of habitat from construction of fuel breaks; and contamination by fire retardants from chemical fire suppression.It is not known what impacts fire and fire management activities have had on historical populations of Sierra Nevada yellow-legged frogs. When a large fire does occur in occupied habitat, Sierra Nevada yellow-legged frogs are susceptible to direct mortality (leading to significantly reduced population sizes) and indirect effects (habitat alteration and reduced breeding habitat). It is possible that fire has caused localized extirpations in the past.78 FR 24471).

Stressor: Predation
Exposure: Direct
Response: Mortality

Consequence: Reduction in population numbers, decreased reproductive success, increased genetic effects of population bottleneck, increased susceptibility to mortality/extirpation.
Narrative: The most prominent predator of Sierra Nevada yellow-legged frogs is introduced trout, whose significance is well-established because it has been repeatedly observed that nonnative fishes and frogs rarely coexist; and it is known that introduced trout can and do prey on all frog life stages. The multiple-year tadpole stage of the Sierra Nevada yellow-legged frog and the fact that all life stages are highly aquatic increases the frog's susceptibility to predation by trout (where they co-occur) throughout its lifespan. Introduced trout are effective predators on Sierra Nevada yellow-legged frog tadpoles, and the introduction of trout is the most likely reason for the decline of the Sierra Nevada yellow-legged frog complex. This threat is a significant, prevalent risk to Sierra Nevada yellow-legged frogs range-wide, and it will persist into the future (78 FR 24471).

Stressor: Disease
Exposure: Direct
Response: Increased incidence of disease and mortality.
Consequence: Reduction in population numbers, decreased reproductive success, increased genetic effects of population bottleneck, increased susceptibility to mortality/extirpation.
Narrative: Over roughly the last 2 decades, pathogens have been associated with amphibian population declines, mass die-offs, and even extinctions worldwide. One pathogen strongly associated with dramatic declines on all five continents is the chytrid fungus, Batrachochytrium dendrobatidis (Bd). This chytrid fungus has now been reported in amphibian species worldwide. Bd is now widespread throughout the Sierra Nevada and, although it has not infected all populations at this time, it is effectively a serious and substantial threat range-wide to the mountain yellow-legged frog complex.Other diseases that may be present within the range of the Sierra Nevada yellow-legged frog have also been reported as adversely affecting amphibian species. These include red-leg disease, caused by the bacterial pathogen Aeromonas hydrophila and other pathogens; Saprolegnia, a globally distributed fungus that commonly attacks all life stages of fishes (especially hatchery-reared fishes) and, more recently, amphibian species; ranaviruses (Family Iridoviridae); and pathogens such as Aeromonas hydrophila.The contribution of Bd as an environmental stressor and limiting factor on Sierra Nevada yellow-legged frog population dynamics is currently extremely high, and it poses a significant future threat to remnant uninfected populations in the southern Sierra Nevada. Its effects are most dramatic following the epidemic stage as it spreads across newly infected habitats; massive die-off events follow the spread of the fungus, and it is likely that survival through metamorphosis is substantially reduced even years after the initial epidemic. The relative impact from other diseases and the interaction of other stressors and disease on the immune systems of Sierra Nevada yellow-legged frogs remains poorly documented to date (78 FR 24471).

Stressor: The inadequacy of existing regulatory mechanisms.
Exposure: Indirect
Response: Lack of protection/enforcement.
Consequence: Reduction in population numbers, decreased reproductive success, increased genetic effects of population bottleneck, increased susceptibility to mortality/extirpation.
Narrative: Regulatory mechanisms currently in place include The Wilderness Act of 1964, the National Forest Management Act of 1976, the Sierra Nevada Forest Plan Amendment, the Federal Power Act, the California Endangered Species Act, and California Department of Fish and Wildlife (CDFW) management plans for basins within the range of the Sierra Nevada yellow-

legged frog. These existing federal and state laws and regulatory mechanisms currently offer some level of protection for the mountain yellow-legged frog complex (78 FR 24471).

Stressor: Climate change.
Exposure: Indirect
Response: Change in climatic conditions; change in snowfall; change in temperature; change in habitat suitability/availability.
Consequence: Reduction of water resource availability, increased stress levels, reduction in population numbers, decreased reproductive success, increased genetic effects of population bottleneck, increased susceptibility to mortality/extirpation.
Narrative: In the Sierra Nevada ecoregion, climate models predict temperature change (warming), which would result in warmer winters, earlier spring snowmelt, and higher summer temperatures; this in turn would lead to higher winter streamflows, earlier runoff, and reduced spring and summer streamflows, with increasing severity in the southern Sierra Nevada. The results of such climate change to the Sierra Nevada yellow-legged frog include an increased severity of some winter storms that may freeze lakes to greater depths, resulting in longer hibernation times, less time available for feeding/breeding, and a subsequent increase in stress levels; a decrease in the availability of deeper lakes that once supported frog populations (but now harbor introduced trout), leading to a loss of breeding/feeding habitat and a greater frequency of tadpole stranding and death; change in breeding cues toward earlier in the year, leading to longer growth and development periods and larger individuals, but also an increase in frequency of tadpole (or egg) exposure to killing frosts during variable spring weather; an alteration to invertebrate communities, which could have a negative impact on the mountain yellow-legged frog prey base; an increase in fire intensity and magnitude, resulting in changes to vegetation communities, water chemistry, and nutrient input and subsequent stress to individuals; changes in the virulence, distribution, and vectors of pathogens, rendering individuals more susceptible to disease; and changes in/barriers to dispersal, emigration, and immigration, preventing adaptive range shifts, recolonization, and genetic exchange. Climate change represents a substantial future threat to the persistence of Sierra Nevada yellow-legged frog populations (78 FR 24471).

Stressor: Small population size.
Exposure: Indirect
Response: Decreased ability to respond to changing conditions.
Consequence: Reduction in population numbers, decreased reproductive success, increased genetic effects of population bottleneck, increased susceptibility to mortality/extirpation.
Narrative: Remaining populations for both the Sierra Nevada yellow-legged frog are small in many localities. About 90 percent of watersheds have fewer than 10 adults, and 80 percent have fewer than 10 subadults and 100 tadpoles. Remnant populations in the far northern extent of the range for the Sierra Nevada yellow-legged frog (from Lake Tahoe north) currently also exhibit very low abundances. The combination of low numbers and other extant stressors of disease, fish persistence, and potential for climate extremes could have adverse consequences for the mountain yellow-legged frog complex as populations approach the Allee threshold (positive correlation between population density and individual fitness). Small population size is currently a significant threat to most populations of Sierra Nevada yellow-legged frogs across the range of the species (78 FR 24471).

Recovery

Reclassification Criteria:
Need to develop reclassification criteria and Recovery Plan.

Recovery Priority Number: 5

Delisting Criteria:
Need to develop delisting criteria and Recovery Plan.

Recovery Actions:
- Need to develop recovery actions and Recovery Plan.
-

Additional Threshold Information:
-
-

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SPECIES ACCOUNT: *Typhlomolge (= Eurycea) rathbuni* (Texas blind salamander (= Eurycea))

Species Taxonomic and Listing Information

Commonly-used Acronym: TBS

Listing Status: Endangered; Southwest Region (R2) (USFWS, 2015)

Physical Description

The TBS is a smooth, unpigmented, stygobitic (obligate aquatic cave-adapted) species. Adults attain an average length of about 4.7 inches (12 cm) with a large, broad head, and reduced eyes. The limbs are slender and long with four toes on the fore feet and five toes on the hind feet (Longley 1978).

Taxonomy

The Texas blind salamander (Eurycea rathbuni) is a member of the family Plethodontidae (lungless salamanders). The type specimens of the Texas blind salamander were collected in 1895 at the Federal Fish Hatchery in San Marcos, Texas, where they were expelled from an artesian well drilled to supply water to the hatchery (Longley 1978, p. 2). The Texas blind salamander was first described by Stejneger (1896, entire), after the type specimen No. 22686, USNM (U.S. National Museum). The species was previously assigned to the genus Typhlomolge, but genetic studies indicate placement of this species within Eurycea (Chippindale 1995, entire; Chippindale et al. 2000, pp. 20, 23-24; Devitt et al. 2019, p. 2628). A technical correction published in 2021 officially recognized the genus change from Typhlomolge to Eurycea (86 FR 67352). Typhlomolge is still sometimes used as a subgenus within Eurycea. The subgenus Typhlomolge is most closely related to the other central Texas Eurycea species that occur south of the Colorado River (Devitt et al. 2019, pp. 2627-2628). The Texas blind salamander is most closely related to the Austin blind salamander, E. waterlooensis (Hillis et al. 2001, pp. 266, 274; Devitt et al. 2019, pp. 2627-2628). There are several morphological differences between these species (Hillis et al. 2001, entire). While other troglobitic Eurycea occur nearby in Comal County, they group genetically with E. latitans (USFWS, 2024b)

Current Range

The Texas blind salamander is currently known from eight sites in Hays County, Texas, that include wells, fissures, caves and high and low flow springs: Diversion Spring, Sessom Springs, Rattlesnake cave, Rattlesnake well, Primer’s fissure, Johnson’s well, Texas State University artesian well, and Spring Lake outflow well (Russell 1976, pp. 1-4; Longley 1978, pp. 12-18; Chippindale 2009, pp. 8-11). Historically, the species also was collected at Wonder Cave (also known as Beaver or Beavers Cave) in 1917 (Uhlenhuth 1921, p. 87), but the cave has been modified, and searches in 1977 and since have not found any salamanders (Longley 1978, p. 17). A genetic assessment of population structure in wild Texas blind salamanders was conducted; preliminary results suggest there is not substantial genetic structure in the wild (Chippindale 2009, entire; Chippindale and Gluesenkamp, 2011, entire). Hydrogeologic studies suggest significant connectivity among these groundwater collection sites exists (Krejca 2007, p. 3). The Blanco blind salamander, Eurycea robusta, was found from drilling along the Blanco River and was suggested to either be extinct or could possibly be the Texas blind salamander (87 FR

14227), although no analyses have been done to consider this latter possibility. Groundwater connectivity would facilitate subterranean movement between San Marcos and this area on the Blanco River (USFWS, 2024).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food Source

Adult: Amphipods, blind shrimp, daphnia, small snails (USFWS, 2024b)

Food/Nutrient Narrative

Adult: The TBS is an active predator. It moves its head from side to side as it searches for food and hunts by sensing water pressure waves created by prey in the still underground waters where it lives. Prey items include amphipods, blind shrimp (Palaemonetes antrorum), daphnia, small snails, and other invertebrates. Observations of captive individuals indicate that TBS feed indiscriminately on small aquatic organisms and do not appear to exhibit an appreciable degree of food selectivity. Prey items include amphipods, blind shrimp (Palaemon antrorum), daphnia, small snails, and other invertebrates (Longley 1978, p. 24; Hutchins et al. 2016, p. 1537). Observations of captive individuals indicate that Texas blind salamanders feed indiscriminately on small aquatic organisms and do not appear to exhibit an appreciable degree of food selectivity (Longley 1978, pp. 24, 26). Subterranean fauna, such as the Texas blind salamander, are not strictly reliant on a food chain based on photosynthetically-derived organic matter, as chemolithoautotrophy can serve as basal food resources in cave ecosystems absent of sunlight (Hutchins et al. 2016, entire). Stable isotope analyses for nitrogen indicate this species is a predator in the subterranean ecosystem (Hutchins et al. 2016, p. 1536). This analysis also detected differences in diet across individuals (USFWS, 2024). The Texas blind salamander is an active predator. Prey items include amphipods, blind shrimp (Palaemon antrorum), daphnia, small snails, and other invertebrates (Longley 1978, p. 24; Hutchins et al. 2016, p. 1537). Observations of captive individuals indicate that Texas blind salamanders feed indiscriminately on small aquatic organisms and do not appear to exhibit an appreciable degree of food selectivity (Longley 1978, pp. 24, 26). Subterranean fauna, such as the Texas blind salamander, are not strictly reliant on a food chain based on photosynthetically-derived organic matter, as chemolithoautotrophy can serve as basal food resources in cave ecosystems absent of sunlight (Hutchins et al. 2016, entire). Stable isotope analyses for nitrogen indicate this species is a predator in the subterranean ecosystem (Hutchins et al. 2016, p. 1536). This analysis also detected differences in diet across individuals (Hutchins et al. 2016, p. 1536). (USFWS, 2024b)

Reproductive Strategy

Adult: Oviparity

Lifespan

Adult: ~ 10 years (USFWS, 2024)

Reproduction Narrative

Adult: The TBS is a neotenic species believed to be adapted to the relatively constant temperatures (69.8°F) of the water-filled subterranean caverns of the Edwards Aquifer in the San Marcos area (Longley 1978). Juveniles have been collected throughout the year, making it likely that this species is sexually active year-round (Longley 1978). The species does not have reliable external characters that can be used to distinguish between the sexes (Service 1996). See Bechler (1988) for description of courtship behavior. Gravid females and small juveniles have been found throughout the year. (NatureServe, 2015). In captivity, Texas blind salamanders are classified as juveniles from hatching to two years old (10-35 mm [0.4-1.4 in] snout to vent length); subadults from two to three years old (35-50 mm [1.4-2.0 in] snout to vent length; eggs and testes may be visible), and sexually mature adults from three years of age and up (50 mm [2.0 in] and greater snout to vent length, eggs and testes visible) (Vieira et al. 2020, p. 7). Captive female Texas blind salamanders become gravid at 1.5 to 2 years of age, but the presence of eggs does not necessarily result in the production of offspring. Individuals continue to grow throughout their lifespan, which is estimated to be 10 years in the wild based on size (Petranka 1998, p. 274; Chippindale and Price 2005, p. 761). Captive animals are known to experience greater longevity; one captive female is estimated to be 20 years old and measured 146.5 mm (5.8 in) (Vieira et al. 2020, p. 7). Growth rate throughout the life of the species does not remain constant. Texas blind salamanders exhibit the fastest growth rate as juveniles, then growth rate progressively decreases with age (Vieria et al. 2020, p. 7). These growth rates may vary in wild salamanders due to variations in food resource availability and temperature, which can vary widely and affect amphibian growth. Records from captive Texas blind salamanders from 2008-2020 indicate an average clutch size of 23.8 eggs per female (n= 81 clutches) (Vieira et al. 2020, pp. 7-8). Wild Texas blind salamander larvae are found throughout the year; thus, breeding is hypothesized to be seasonally unrestricted (Longley 1978, p. 26). Larval abundance in the wild fluctuates greatly, and reproductive cues are unknown (Vieira et al. 2020, p. 7). Distinct from other salamander species, the Texas blind salamander female initiates courtship, and clutch sizes are small. Chemical cues play an important role in social interactions of Texas blind salamanders, indicating water quality may be an important component to the behavior of this aquifer species (USFWS, 2024).

Habitat Type

Adult: water-filled subterranean caverns (Natureserve, 2015)

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 Texas blind salamander is adapted to the water-filled subterranean caverns of the Edwards Aquifer in the San Marcos area (Longley 1978, p. 21). Observations indicate that this salamander moves through the aquifer by traveling along submerged ledges and may swim short distances before spreading its legs and settling to the bottom of the pool (Longley 1978, p. 21). For additional details on the habitat and water quality conditions of the spring ecosystem at San Marcos Springs (USFWS, 2024b)

Dispersal/Migration

Motility/Mobility

Adult: Nonmigratory

Dispersal/Migration Narrative

Adult: Observations indicate that this salamander moves through the aquifer by traveling along submerged ledges and may swim short distances before spreading its legs and settling to the bottom of the pool (Longley 1978).

Population Information and Trends

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

Unknown (NatureServe, 2015)

Population Narrative:

Little is known about the population size or trends in population for this species and no reliable estimates are available. The species' range has been hypothesized to be as small as 39 square miles beneath and near the city of San Marcos (Longley 1978). Few data, but likely relatively stable in extent of occurrence; uncertain long-term trend in population size, area of occurrence, and number/condition of occurrences. Decline of <30% to increase of 25% Total adult population size is unknown. Specimens have been collected from several sites, but the number of distinct occurrences is uncertain. (NatureServe, 2015)

Threats and Stressors

Stressor: Water quality/springflow
Exposure:
Response:
Consequence:
Narrative: Threats to the TBS identified in the San Marcos and Comal Springs and Associated Aquatic Ecosystems Recovery Plan (Service 1996) include loss of springflows due to decreases in aquifer levels; water quality declines (including a loss of historically stable thermal conditions); human modifications (such as bank stabilization, dams, and landowner maintenance activities in waterways and on adjacent tracts of land) that have changed the historical magnitude and occurrence of episodic events such as flooding, and indirect impacts from surrounding development and urbanization; and introduction of non-native species. This environmental baseline describes the current status of the species and is based upon impacts to which the species has been exposed (U.S. Fish and Wildlife Service and National Marine Fisheries Service1998). To understand the potential effects of the currently authorized and actual pumping amounts as managed by the existing Edwards Aquifer Authority (EAA) Critical Period Management (CPM) Plan, springflow was modeled for a 54-year period (1947 through 2000) that included a range of precipitation conditions including the Drought of Record (DOR) event that occurred from 1949 to 1956. While the Edwards Aquifer MODFLOW model (HDR Engineering, Inc. et al. 2011) estimates monthly average discharge at San Marcos Springs, it does not inform us of what effects may be expected in the TBS habitat of the recharge and artesian zone in the

San Marco area. Springflows are a function of aquifer level, and the reduction and loss of springflows projected by these modeling efforts during severe drought conditions suggests lowered aquifer levels. Given the TBS's apparent restriction to the waters of the aquifer in Hays County, these lowered aquifer levels may represent impacts to the species and its habitat.

Recovery

Reclassification Criteria:
Recovery Priority Number: 5

1. All populations of each species, in all management units where the species is present, maintain sufficient resiliency for 18 consecutive years. For surface species (fountain darter, Comal Springs riffle beetle, and Texas wild-rice), sufficient resiliency will be achieved when: a. Populations do not trend toward a decline and do return to the cumulative mean after short-term fluctuations (cumulative mean is defined here as the mean of the dataset over time, also known as a running average); b. Populations do not fluctuate below the cumulative mean of non-drought years (nondrought years is defined as the mean of previous years that Comal or San Marcos springs did not decrease below 2.83 meters squared per second (m3 /s) (100 cubic feet per second [cfs]) by more than 10% in a given year; c. Populations do not decline from the cumulative mean of non-drought years more than 25% during drought years when Comal or San Marcos springs decreases below 2.83 m3 /s (100 cfs); and d. Populations do not decline from the cumulative mean of non-drought years more than 50% during a repeat of the Drought of Record or worse (Drought of Record is defined in this document as a three-year period when aquifer recharge is 397,800 acre-feet (ac-ft) total or less, which last occurred from 1954-1956). Methods used for animal species (fountain darter, Comal Springs riffle beetle) should estimate population size (based on, e.g., capture-recapture, depletion) rather than using counts of individuals as a surrogate to estimate population. For subsurface species (Comal Springs dryopid beetle, Peck's cave amphipod, and Texas blind salamander), sufficient resiliency is achieved when: surface species have also achieved sufficient resiliency, subsurface species are observed twice a year from known spring outflows during nondrought conditions, and subsurface species are observed in accessible subsurface habitat (e.g., caves, wells) during all springflows when wet. (USFWS, 2025)

All species: Habitat is protected, restored and maintained within each management unit in the areas described below (see the SBR for additional information on habitat within each management unit; USFWS 2025a, Section 1.0). The habitat restoration should achieve a level that supports resilient populations as described in downlisting criterion 1. This initiative should include restoration of terrestrial riparian areas aimed at minimizing runoff into adjacent aquatic habitat for the benefit of all species, while also providing suitable habitat and food resources for the Comal Springs dryopid beetle, Peck's cave amphipod, and Comal Springs riffle beetle. The habitat restoration may occur with existing hydromorphological modifications if adequate habitat can be achieved. However, if there are any additional hydromorphological modifications, they should support a more natural ecosystem condition (e.g., impoundment removal, dechannelization, natural substrate) instead of leading to a more unnatural ecosystem. While it is expected that habitat may change during droughts and floods (e.g., siltation during low flows, loss of substrate or vegetation), the habitat management plan described in downlisting criterion 3 should restore habitat in the locations described here. After completion, the habitat restoration should be maintained for at least 18 years. Comal Ecosystem: • Comal Springs dryopid beetle: Spring runs 1 through 5 and 7, western shoreline, and spring island. These areas maintain the primary constituent elements that were identified in the rule designating critical habitat (78 FR 63100). Panther Canyon Well remains undisturbed. • Comal Springs riffle beetle: Spring runs 1 through 3, western shoreline, and spring island. These areas maintain the primary constituent elements that were identified in the rule designating critical habitat (78 FR 63100). • Fountain darter: At least 100,000 square meters (m2) (10 hectares (ha) [24.7 acres (ac)]) of native submerged aquatic vegetation when flows are above 2.83 m3 /s (100 cfs), with a diversity of plant species that are demonstrated to provide fountain darter habitat (see SBR, USFWS 2025a, Section 1.5.3). Vegetation should be distributed through Landa Lake, spring runs, and the old and new channel. • Peck's cave amphipod: Spring runs 1 through 4 and 7, western shoreline, and spring island. These areas maintain the primary constituent elements that were identified in the rule designating critical habitat (78 FR 63100). Panther Canyon Well remains undisturbed. San Marcos Ecosystem: • Comal Springs dryopid beetle: Sessom Springs area. This area maintains the primary constituent elements that were identified in the rule designating critical habitat (78 FR 63100). • Comal Springs riffle beetle: Hotel area of Spring Lake (see Figure 3). This area maintains the primary constituent elements that were identified in the rule designating critical habitat (78 FR 63100). • Fountain darter: At least 40,000 m2 (4 ha [9.9 ac]) of native submerged aquatic vegetation in the Upper San Marcos River (not including Spring Lake) when flows are above 2.3 m3 /s (80 cfs), with a diversity of native species that are demonstrated to provide fountain darter habitat (see SBR, USFWS 2025a, Section 1.5.3). This amount of vegetation is in addition to any Texas wild-rice in the river. Abundant vegetation also continues to exist in Spring Lake for fountain darters. Vegetation should be distributed through Spring Lake and the Upper San Marcos River until the confluence with the Blanco River, with the expectation that vegetation density will be higher in the upstream reaches. This number does not include the Martindale area. Additional research will be needed to evaluate the possible fountain darter habitat in the Martindale area. • Texas blind salamander: Cave habitat remains unmodified and undisturbed. • Texas wild-rice: At least 20,000 m2 (2 ha [4.9 ac]) of Texas wild-rice is maintained in the upper San Marcos River, including areas that are shallow enough to allow for natural seeding. Texas wild-rice should be distributed through the Upper San Marcos River to the City of San Marcos wastewater treatment plant outfall. Hueco Ecosystem: • Peck's cave amphipod: Designated surface critical habitat maintains the primary constituent elements that were identified in the rule designating critical habitat (78 FR 63100). If this site becomes accessible, habitat should be evaluated to assess the potential need for additional restoration and management. Fern Bank Ecosystem: • Comal Springs dryopid beetle: Designated surface critical habitat maintains the primary constituent elements that were identified in the rule designating critical habitat (78 FR 63100). If this site becomes accessible, habitat should be evaluated to assess the potential need for additional restoration and management. (USFWS, 2025)

3. All species: There is a habitat management plan that is fully implemented and focuses on habitat restoration and reducing habitat degradation for all waters and lands associated with management units to ensure that habitat continues to sustain resilient populations of each species. The habitat management plan should address how habitat will be managed when the needs of different listed species conflict, along with management of threats to habitat, including recreation, runoff, drought, floods, and harmful non-native species. The habitat management plan will be fully implemented in all management units for the species for at least 18 years. (USFWS, 2025)

All species: The daily average discharge during the 18-year period in the Comal River exceeds 6.4 m3 /s (225 cfs) including the Drought of Record or worse (i.e., a three-year period when aquifer recharge is 397,800 ac-ft total or less), and the minimum daily average flow is not less than 0.9 m3 /s (30 cfs). In the San Marcos River, the daily average discharge during the 18-year period exceeds 4 m3 /s (140 cfs) including the Drought of Record or worse (i.e., a three-year period when aquifer recharge is 397,800 ac-ft total or less), and the minimum daily average flow is not less than 1.3 m3 /s (45 cfs). The duration of minimum daily average flows in both rivers must not exceed six months and is followed by three months of 2.3 m3 /s (80 cfs) or greater to ensure adequate habitat and water quality. Achievement of this criterion will be measured using continuous monitoring data from streamflow gages at Comal and San Marcos springs (USGS 08168710 and 08170000) for a minimum of 18 years. Hueco Springs is located close to Comal Springs, and it shows a similar flow pattern to Comal Springs during droughts, based on U.S. Geological Survey gages (Hueco Springs gage 0816800 and Comal Springs gage 08168710). Therefore, Comal Springs will be used as a surrogate for the Hueco Springs flows needed. For Fern Bank Springs, more information will need to be gathered to evaluate the water quantity that is adequate for recovery. A groundwater management plan or equivalent conservation agreement should ensure adequate water quantity that is fully implemented for a minimum of 18 years. It is possible that future habitat restoration or management may be able to reduce the flows necessary to maintain adequate habitat, in which case these flow thresholds should be reevaluated. (USFWS, 2025)

All species: Water quality consistently meets or exceeds established Environmental Protection Agency (EPA) numeric criteria for protection of aquatic life throughout the areas where the species are present (EPA 2022, unpaginated). Water temperature in surface habitat does not exceed 25°C (77°F) near springs (areas within spring runs, Spring Lake, the main spring outlets at Sessom, Landa Lake, Spring Island, Panther Canyon Well, Hueco Springs, and Fern Bank Springs), other surface habitat does not exceed this temperature at least 50% of the days per year at the substrate, and downstream surface habitat at the substrate does not exceed 27°C (81°F). Conductivity is between 560-650 microsiemens per centimeter (µS/cm) in the San Marcos Ecosystem Management Unit and 560-610 µS/cm in the Comal Ecosystem Management Unit during conditions that do not contain surface runoff from rainfall. Turbidity is generally less than 1.0 Nephelometric Turbidity Units (NTU) in spring water and habitat. Water quality measurements should only be considered when taken during baseflow conditions that do not contain surface runoff. Areas of very shallow habitat during drought conditions should not be considered for this criterion. This criterion will be achieved when these standards are met throughout the species habitat within each management unit, as described in Criterion 2, above, during quarterly sampling for 18 years. For Fern Bank and Hueco springs, more information will need to be gathered to evaluate the expected conductivity, turbidity, pH, and temperature at these springs. Research may also be needed to evaluate species-specific groundwater quality needs if there is a concern that the EPA numeric criteria for aquatic life may not adequately address water quality needs or if EPA numeric criteria have not been established. (USFWS, 2025)

All species: A self-sustaining refugia population in captivity is capable of maintaining at least 90% of the genetic diversity from the wild for 10 years without collections, as determined by population genetic modeling and a population with lambda of 0.95 or greater. This captive population may be used for population reintroduction and augmentations, or emergency refugia in case of catastrophic loss in the wild. This minimum target captive population size should be 500 individuals unless new science indicates that another number is more appropriate for these goals. If research compromises individuals for these goals, those individuals should not be included as part of the refugia population. There should be refugia populations for every species population in the San Marcos Ecosystem, and for every management unit for the three invertebrate species (Table 1). (USFWS, 2025)

Fountain darter and Texas blind salamander: Disease and parasites do not negatively affect the resiliency (defined as no more than 20% of individuals sampled) of any wild population for 10 years. (USFWS, 2025)

Delisting Criteria:
All species: All populations maintain resiliency for 45 consecutive years and are expected to maintain resiliency in the future. Populations will be considered resilient when they meet the definition described in downlisting criterion 1 above. For the San Marcos salamander, the criterion for surface species should be followed. (USFWS, 2025)

All species: Habitat can sustain resilient populations and is protected/restored/maintained as described above in downlisting criterion 2, maintained for at least 45 years, and anticipated to remain protected/restored/maintained due to the actions of the habitat management plan described in downlisting criterion 3. Habitat for the San Marcos salamander is not included in downlisting criterion 2 and should meet the criteria provided for all species, as well the following for the San Marcos ecosystem: Approximately 6000 m2 (0.6 ha [1.5 ac]) of unembedded cobble and gravel substrate with low macrophyte cover is maintained through Spring Lake and the upper 50 m (164 ft) of the river when flows are above 2.3 m3 /s (80 cfs) and maintain at least 3000 m2 (0.3 ha [0.7 ac]) of unembedded substrate when flows are below 2.3 m3 /s (80 cfs). Surface habitat should connect to a groundwater source, such as a spring. (USFWS, 2025)

All species: Future habitat degradation is prevented through a habitat management plan as described above in downlisting criterion 3. The habitat management plan will be fully implemented for at least 45 years and anticipated to continue for at least 75 years into the future (USFWS, 2025)

All species: The flows in downlisting criterion 4 are achieved for 45 years. Flows are expected to continue for at least 75 years into the future through actions of a fully implemented water management plan. (USFWS, 2025).

All species: Groundwater quality in downlisting criterion 5 is achieved for 45 years and there is no indication that water quality is degrading over time, as determined by increasing trends in nutrients, conductivity, or contaminants. (USFWS, 2025).

All species: Captive populations continue to be maintained as described in downlisting criterion 6. This will continue until the five years of post-delisting monitoring is completed. (USFWS, 2025)

Fountain darter, San Marcos salamander, Texas blind salamander: Disease and parasites do not affect the resiliency of any wild population for 45 years as defined in downlisting criterion 7 and are not anticipated to affect the resiliency for at least 75 years into the future. (USFWS, 2025)

Recovery Actions:

- Recovery tasks identified in the San Marcos and Comal Springs and Associated Aquatic Ecosystems Recovery Plan (Service 1996) include: assuring adequate water levels and water quality in the aquifer, establishment of captive breeding populations with sufficient genetic integrity and development of reintroduction techniques, addressing local threats to water quality and quantity, and ensuring that self-sustaining populations of the species exist throughout its range.
- The TBS has been the subject of two formal consultations for Federal actions unrelated to the action considered here. The Service completed an intra-Service consultation addressing the continuing operations and refugia at the San Marcos National Fish Hatchery and Technology Center and the Uvalde National Fish Hatchery. We determined the proposed action would not jeopardize the TBS. The Service consulted on the issuance of the EARIP HCP ITP.
- 1. Recovery Action 1: Ensure Adequate Water Quantity and Quality within the Southern Edwards Aquifer and Management Units. Priority 1. • Recovery Activity 1-1: Gather information necessary to determine water quantity needed at each Management Unit. Information needs to be gathered and evaluated to ensure adequate water quantity to the Management Units at levels that protect the species and their habitat. This will involve monitoring of aquifer levels and spring flow under normal and drought conditions, modeling the impact of drought, groundwater pumping, and climate change on aquifer levels and spring flows, and incorporating any new information into water quantity requirements for each species at each Management Unit. Implement measures to provide adequate water quantity. Continuous flow monitoring should be implemented at Fern Bank Springs as part of this activity. • Recovery Activity 1-2: Implement measures to provide adequate water quantity. To protect habitat, a comprehensive water management plan or equivalent would protect water quantity. This should include a regional aquifer management plan and the protection of aquifer recharge features. Long-term commitments need to be in place to ensure that these protections will continue in perpetuity. The plan must also identify how regional water needs will be met while considering these water limitations during severe droughts that could occur as a result of climate change. Considering comprehensive water planning should help ensure that the aquifer is not depleted due to lack of alternative water sources. • Recovery Activity 1-3: Evaluate the effectiveness of measures to provide adequate water quantity. Long-term water quantity monitoring should evaluate how well the implemented measures are protecting water quantity, especially during droughts. This monitoring campaign will include using the aquifer level, springflow, and groundwater pumping data collected by local groundwater conservation districts, Texas Water Development Board, U.S. Geological Service, and other entities. These data will be placed into a management framework that identifies critical aquifer levels and associated on-the-ground habitat conditions. This information should also be used to update the Contingency Plan for springflow triggers to salvage species for the refugia if needed. Projected frequency of droughts and groundwater levels used in models should be validated with data collected during future drought conditions. • Recovery Activity 1-4: Model effects of projected future land use changes on water quality and aquifer recharge, and whether additional land protection is needed. Increasing development and associated impervious cover in the contributing, recharge, and artesian zones of the Edwards Aquifer threatens water quality, may affect recharge, and increases the risk of catastrophic spills. Modeling these effects is necessary to consider for preventing water quality degradation and whether land preservation in the contributing and recharge zones is needed. • Recovery Activity 1-5:

Develop and implement effective measures to avoid chronic water quality degradation and maintain aquifer recharge. Measures to avoid or limit chronic water quality degradation should be developed, implemented, and when needed, modified to ensure their effectiveness. These measures could involve land acquisition, conservation easements, best management practices, impervious cover regulations, buffer zones, outreach programs, and numerous other tools. Evaluate the effectiveness of these measures. • Recovery Activity 1-6: Develop and implement effective measures to avoid chronic water quality degradation, contaminant spills, and maintain aquifer recharge. Measures to avoid or limit spills and chronic water quality degradation should be developed, implemented, and when needed, modified to ensure their effectiveness. These measures could involve land acquisition, conservation easements, best management practices, impervious cover regulations, buffer zones, outreach programs, and numerous other tools. Plans should also be developed to reduce the risk of spill and reduce the impacts of spills through containment to avoid contaminants entering groundwater. These measures should also evaluate the effectiveness of these measures. • Recovery Activity 1.7: Monitor the physical and chemical constituents (sediment, nutrients, ions, and contaminants) present during baseflow and stormflow conditions at the springs. Information should be collected on the physical and chemical constituents of greatest concern during baseflow and stormflow conditions. This research should also be designed to evaluate the effectiveness and modify, if necessary, the measures that avoid or minimize water quality degradation. • Recovery Activity 1-8: Consult with environmental agencies on effects of wastewater discharges. Use interagency consultation to evaluate the combined effects of permitted wastewater discharges and future permitted discharges in the recharge and contributing zone on water quality in the Management Units. Implement conservation measures as part of the consultations to protect water quality. (USFWS, 2024a)

- 2. Recovery Action 2. Protect and Restore Habitat in Waters and on Lands Within and Adjacent to the Management Units. Priority 1. • Recovery Activity 2-1: Control non-native species. Control or eliminate non-native species spread that outcompete native flora and fauna, contribute to scouring flood severity, and reduce the adaptive capacity and resiliency of listed species’ populations within the Management Units. Additionally, proactive measures to reduce conditions preferred by non-native species should be a long-term priority. Regulations to prevent the spread or introduction of non-native species should be enforced through TPWD and the Service. Private landowners should be educated on illegal activity reporting and prevention of introducing non-native species that may adversely affect the habitats within the Management Units. • Recovery Activity 2-2: Reduce human disturbance in habitat. Reduce unintentional disturbance from recreation using measures such as designated access points and prohibiting access in sensitive areas. Intentional disturbance (e.g., from vegetation removal and littering) could be reduced from education, availability of alternatives that would prevent the disturbance, and from legal enforcement. • Recovery Activity 2-3: Develop and implement habitat management plans. Management plans should include descriptions of on-the-ground projects and activities necessary to improve or maintain adequate high-quality habitat in which the species’ populations can be resilient. This may include erosion control strategies and reducing mechanical disturbances in coordination with local jurisdictions, resource management agencies, and private landowners. Land development effects should be minimized using best management practices. Sediment removal projects, in coordination of resource management agencies and industries, should minimize disturbance to the habitat where possible, to enhance areas of diminished habitat value. The habitat can be evaluated to determine if it has degraded to the point where specific habitat restoration projects would be beneficial to improve habitat. Adjacent riparian zones should be included in the habitat management plans to protect aquatic habitat. Additionally, the habitat management plans should include abatement strategies for existing threats and measures to identify undetected threats as new information becomes available. • Recovery Activity 2-4: Protect and restore habitat at Fern Bank and Hueco springs. Access to these springs is needed to evaluate habitat restoration needs. Easements or other conservation agreements could be used to protect these springs from human disturbance. • Recovery Activity 2-5: Evaluate the efficacy of recovery activities in protecting and restoring species habitat. Plans and activities should be reviewed and revised as needed based on outcomes from activities and new information. (USFWS, 2024a)

- 3. Recovery Action 3: Establish and Implement a Captive Population Management Plan and Reintroduction Plan. Priority 1 for San Marcos salamander, Texas blind salamander, Texas wild-rice; Priority 2 for Comal Springs riffle beetle, Comal Springs dryopid beetle, Peck's cave amphipod, fountain darter. • Recovery Activity 3-1: Determine optimal conditions for captive breeding of each listed species. Ensure that each species has captive conditions that maximize life expectancy and reflect or exceed life expectancy of wild individuals. Ensure that under captive conditions, most individuals successfully reproduce and offspring from most broods survive until maturity and also reproduce. Until the optimal conditions have been determined for a species, large numbers of a species should not be kept in captivity because they will not be useful for the activities outlined in 3.3 or provide a safeguard against extinction. • Recovery Activity 3-2: Maintain captive breeding programs of each of the listed species. Captive breeding programs for each species will be maintained until threats to the species are ameliorated and delisting is achieved. The program is intended to achieve the goals of the plan described in 3.3. However, captive breeding programs should be established even if the plan has not yet been created to safeguard against extinction.+ • Recovery Activity 3-3: Develop and implement a comprehensive strategy for the six endangered species. This includes developing and updating Captive Propagation, Contingency, and Reintroduction Plans to ensure their long-term survival. Regular reassessment and adjustments (e.g., annually) are essential. The Captive Propagation plans should be consistent with the USFWS "Policy Regarding Controlled Propagation of Species Listed Under the Endangered Species Act" (USFWS and NOAA 2000, entire). The plan should address four captive rearing situations: 1) captive rearing during non-crisis times in the event of a rapidly developing crisis when there is no time to collect wild animals, 2) collection and captive rearing of animals as a response to a rapidly developing crisis in which there is time to collect additional wild animals, 3) collection and captive rearing of animals in response to a slowly developing crisis, and 4) captive rearing of animals during non-crisis times without a developing crisis (i.e., standard operating procedures). The plans should balance the needs of the captive refugia with those of the wild populations through employing strategies that minimize the need for collecting wild individuals, while still fulfilling plan objectives. The Contingency Plans should establish the protocols needed to respond to crisis situations, including the emergency threat of water quantity (springs drying or limited flow), water quality (contaminant events such as oil spills), habitat fragmentation or isolation, or habitat loss. Contingency planning should be regularly updated, independent of the completion of genetic, breeding, and reintroduction studies. To mitigate the risk of extirpation before further collections can be made, the plans must address: maintaining and reproducing the species in captivity for multiple generations, maintain a sufficient captive population with genetic diversity representative of the wild for an extended period without the possibility of additional collections in case of extirpation from the wild, managing diseases and parasites in captivity, and incorporating strategies to avoid artificial selection that could reduce successful reintroductions. The Reintroduction Plans should adhere to standard guidelines for reintroduction plans (e.g., Association of Zoos & Aquariums). They should outline the process and circumstances under which the captive population(s) would be reintroduced into the wild, address research needed to improve reintroduction success (White et al. 2015, entire), consider the possibility of multiple reintroduction attempts, address contingency plans if reintroduction is unsuccessful, and include a post-release monitoring plan. The plan should be developed in coordination with agencies, permittees, and academic experts to ensure collection efforts maintain genetic diversity and population viability. An existing contingency plan exists (USFWS 1996) for managing salvage collections from the wild, though it requires substantial updates to align with current knowledge of the species. Additionally, a Participation Plan should be developed in coordination with the USFWS that outlines the level of commitment that partner facilities will implement this plan (i.e., long-term versus short-term holding facilities), personnel willing to collect and transport animals, research to be conducted, and level of information to be collected. The CPCP and Participation Plans. should regularly updated. (USFWS, 2024a)

- 4. Recovery Action 4: Promote Edwards Aquifer Species Conservation and Recovery through outreach, education, and cooperation. Priority 3. • Recovery Activity 4-1: Provide outreach and education to local communities. Partners and management agencies will conduct outreach through events and engaging social media posts. Additionally, events and workshops hosted to the local community (e.g., tribes, local governments, citizens, and associations within the taxon’s range) should use strategies to seek out broad participation, including those that may not pursue conservation-focused events. Development and installation of interpretive signage should be considered to improve public awareness and appreciation for the ecosystems the seven species depend on and conservation of aquifer and aquatic habitats in general. • Recovery Activity 4-2: Promote cooperation and provide incentives and education for private landowners, land managers, and businesses. All habitat within management units in which land managers, landowners, and businesses are the primary caretaker should be incentivized and provided with education on the significance of their cooperation for the recovery of these species. Incentives are encouraged to engage landowners in activities that would improve or restore habitat. This can be achieved through obtaining conservation agreements (e.g., Safe Harbors or easements) whenever possible to protect natural attributes of the property from disturbance, participation or permission for the monitoring of populations, and adaptive management and timeline transparencies for agreements (e.g., Habitat Conservation Plans) with businesses. (USFWS, 2024a)
- 5. Recovery Action 5: Establish and Implement Effective Disease and Parasite Protocols. Priority 2. • Recovery Activity 5-1: Investigate largemouth bass virus in fountain darters. Evaluate whether the virus affecting fountain darters is largemouth bass virus or a novel virus using genetic sequencing. Develop captive techniques to treat this virus and reduce mortality of infected individuals. • Recovery Activity 5-2: Control parasites in fountain darters and salamanders in captivity. Develop captive techniques to treat parasites, reduce mortality, and increase reproduction from infected individuals. • Recovery Activity 5-3: Monitor parasite prevalence at Management Units and assess whether it affects resiliency of wild populations. This action should also investigate the relationship between population trends and parasite prevalence and assess health of infected individuals to assess the extent that parasites are affecting individual fitness. • Recovery Activity 5-4: Control parasites at Management Units if needed. Based on monitoring results, techniques to reduce parasites in the wild may need to be implemented such that the parasites are not decreasing the

resiliency of the population. (USFWS, 2024a)

- 6. Recovery Action 6. Monitor Progress Toward Criteria within the Management Units: Priority 3. • Recovery Activity 6-1: Create and implement monitoring plan to evaluate habitat quality and population resiliency of each species at each Management Unit. This should include mark/recapture or other population level analyses to provide population estimates when feasible, as well as the use of other techniques, such as abundance estimates and eDNA. Data should be statistically analyzed for trends in population and habitat quality over time. Population viability analysis should be performed at each Management Unit. Monitoring data should also be analyzed to evaluate the extent that climate change affects groundwater recharge, water temperature and water quality in species habitat. • Recovery Activity 6-2: Determine data needs for monitoring. Due to the subterranean nature of some of the listed species, it may not be possible to obtain adequate data to assess population size. Other estimates may be needed as surrogates in these cases. For subterranean species populations, presence/absence detection through eDNA sampling may provide suitable information in place of formal monitoring due to the inaccessibility of this habitat, access to private properties where species could occupy, and survey difficulties that result in repeatable detection accuracies. New monitoring techniques that provide better population estimates for subsurface species, and how springflows and groundwater levels affect subsurface habitat should be used if they become available (USFWS, 2024a)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • If possible given workloads, a Species Status Assessment could be conducted to guide the development of a revised recovery plan. We recommend revising the 1996 San Marcos & Comal Springs & Associated Aquatic Ecosystems (Revised) Recovery Plan to incorporate new information, including future climate modeling, and to address specific threats to subterranean species. • Work with cooperators to encourage use tail clipping data generated from years of data collection to formalize a genetic management plan. Use genetic data to generate population estimates within the predicted range of the Texas blind salamander. • Work collaboratively to with partners to conduct regularity scheduled water quality data testing at known Texas blind salamander data collection sites. Work with local municipalities and land owners if water quality is known to be substandard. (USFWS, 2021)

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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:

373 extant populations (USFWS, 2024a)

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). Data show that 626 Eastern Hellbender populations existed across 15 states, and we assumed all historical populations were healthy. Currently, 153 populations (24%) are considered extirpated or functionally extirpated (PX or FX), 373 (60%) are extant, and 100 (16%) are unknown status (US). Of the 373 extant populations, 57 (15%) are declining (D), 42 (11%) are stable and recruiting (SR), 54 (14%) are recruiting with unknown trend (UR), and 220 (59%) have unknown trend (UT). The experts provided their judgments to the likely status of the 320 populations with unknown status or trends. Incorporating the experts' estimates, 255 populations are believed to be extirpated (41%) and 371 (59%) populations are believed extant; of these extant populations, 45 (12%) are believed to be SR, 108 (29%) UR, and 218 (59%) D. Overall, 76% of all historical Eastern Hellbender populations are thought to be either extirpated or declining. The Eastern Hellbender's geographical extent within the MACU is and always has been limited, with five occupied streams in a small region of one state. The OACU is geographically large, with 138 occupied and widely dispersed streams across nine states (i.e., high redundancy). The TACU is also geographically large, with 182 occupied and widely dispersed streams across six states (i.e., high redundancy). The healthy streams in the TACU are concentrated in western North Carolina, eastern Tennessee, and northern Georgia but are still dispersed over a fairly large area (USFWS, 2024a).

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

Reclassification Criteria:
Recovery Priority Number: 3

1. There is a positive population trend for a 30-year period1 that is not contingent on continued augmentation of populations (USFWS, 2024).

2. There is evidence of successful recruitment to maintain a sustaining population, with recruitment defined as attainment of sexual maturity by young that are reproductively viable (USFWS, 2024).

3. Watershed health, such as riparian protection, sediment inputs, and water quality, is sufficient to provide habitat quantity and quality to support all life stages (USFWS, 2024).

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 (USFWS, 2024).

5. Causes of population declines have been identified, it is clear what actions are needed to address these threats, and these actions are being implemented (USFWS, 2024).

Delisting Criteria:
1. Downlisting criteria have been met (USFWS, 2024).

2. Threats and causes of decline have been reduced or eliminated such that downlisting criteria will continue to be met into the foreseeable future (USFWS, 2024).

Recovery Actions:

- 1. Propagate eastern hellbenders in captivity to augment declining, wild populations. (Priority 1) (USFWS, 2024).
- 2. Monitor populations to assess long-term trends. (Priority 1) (USFWS, 2024).
- 3. Using a watershed approach, protect and improve habitat and water quality, which may include land acquisition, conservation easements, and conservation actions and practices on private and public land. (Priority 1) (USFWS, 2024).
- 4. Identify, prioritize, and conduct other research to enhance the conservation and recovery of eastern hellbenders in Missouri. (Priority 1) (USFWS, 2024).
- 5. Monitor and address emerging diseases and other stressors that affect the health of individuals. (Priority 2) (USFWS, 2024).
- 6. Maintain or enhance protections through policy, regulation, and enforcement (such as preventing illegal collection and minimizing impacts to individuals and their habitats). (Priority 2) (USFWS, 2024).
- 7. Initiate educational and public outreach actions to heighten awareness of the hellbender as an endangered species and solicit help with recovery actions. (Priority 3) (USFWS, 2024).

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

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SPECIES ACCOUNT: *Necturus lewisi* (Neuse River waterdog)

Species Taxonomic and Listing Information

Listing Status: Threatened

Physical Description

Neuse River Waterdogs are from an ancient lineage of permanently aquatic salamanders in the genus Necturus. Adult Neuse River Waterdogs have been described by Bishop (1943, p.32), Brimley (1924, p.167), Cahn and Shumway (1926, p.106-107), Viosca (1937, p.138), and Hecht (1958, p.15), while the first accurate descriptions and illustrations of hatchlings and larvae were documented by Ashton and Braswell (1979, pp. 15-22). Hatchlings are light brown in color with dark lines from each nostril through the eye to the gills, with a white patch behind the eye and above the line (Ashton and Braswell 1979, p.17; Figure 2- 1). Their heads are round compared to the square, elongated heads of the adults. Hatchlings have melanophores scattered on the gills, upper surfaces of the legs, lower jaw, and parts of the head, with concentrations highest on the tail, making the tail darker than the head and trunk (Ashton and Braswell 1979, p.17). Hatchlings have developed forelimbs, with three complete toes and the fourth, inner toe is only a bud and the hindlimbs are pressed close to the lower tail fin and not fully developed (Ashton and Braswell 1979, p.17) (USFWS, 2018).

Taxonomy

The Neuse River Waterdog (Necturus lewisi) is one of three species of Necturus in North Carolina. In 1924, Brimley described the Neuse River Waterdog as a subspecies of N. maculosus (Brimley 1924, p.167), primarily because of the “spotted larvae”. The type specimen (USNM 73848) was taken from the Neuse River near Raleigh by F.B. Lewis in 1921. In 1937, Viosca elevated it to a full species (Viosca 1937, p.138), primarily based on the ventral spotting pattern. Brode (1970, pp.5288-5289) suggested that N. lewisi (as N. maculosus lewisi) and N. maculosus (as N. maculosus maculosus) formed an intergrading series of populations. However, in 1980, Ashton et al. (pp.43-46) compared electrophoretic data for N. maculosus, N. punctatus, and N. lewisi, and determined that each is a distinct species. The currently accepted classification is (Integrated Taxonomic Information System 2016): Phylum: Chordata Class: Amphibia Order: Caudata Family: Proteidae Genus: Necturus Species: Necturus lewisi (USFWS, 2018)

Historical Range

The Neuse River Waterdog is endemic to the Tar-Pamlico and Neuse River basins in North Carolina. Its historical distribution includes two physiographic provinces (Piedmont and Coastal Plain) comprising all major tributary systems of the Tar and Neuse, including the Trent River Basin (Cooper and Ashton 1985, p.1; Figures 3-1 and 3-2). Because of salt water influence, the habitats in the Trent River system are isolated from the Neuse River and its tributaries; therefore, we consider the Trent River system as a separate basin (i.e., population), even though it is technically part of the larger Neuse River Basin (USFWS, 2018).

Current Range

NC; Neuse and Tar-Pamlico River Basins in eastern North Carolina. For the purposes of this assessment, populations were delineated using the river basins that Neuse River Waterdogs have historically occupied. This includes the Tar, the Neuse, and the Trent River basins, and from here forward, we will use these terms to refer to populations (e.g., the Tar Population). Of the three historical Neuse River Waterdog populations, all have observations in the last 10 years (Figure 3-4). Because the river basin level is at a very coarse scale, populations were further delineated using management units (MUs). MUs were defined as one or more HUC10 watersheds that species experts identified as most appropriate for assessing population-level resiliency (see Section 3.3). Rangewide species occurrence data were used to create “occurrence heat maps” that categorize HUC10 watersheds based on occupancy. These heat maps display recent observed occurrences in red, newly occupied HUC10s in pink, recently presumed losses in HUC10 occurrence in light blue, and presumed extirpated occurrences are displayed in dark blue (Figure 3-4). Documented species occurrences are included to show distribution within HUC10s and the NC Wildlife Resources Commission has documented sites where the Neuse River Waterdog is below detection (“X” in Figure 3-4), based on their most recent comprehensive surveys (NCWRC 2015). Throughout this section, heat maps are used to characterize the historical and current distribution of Neuse River Waterdog among MUs for each of the three populations (USFWS, 2018).

Critical Habitat Designated

Yes; 7/9/2021.

Legal Description

We, the U.S. Fish and Wildlife Service (Service), list two North Carolina species, the Carolina madtom (Noturus furiosus) as endangered, and the Neuse River waterdog (Necturus lewisi) as threatened, under the Endangered Species Act of 1973 (Act), as amended. We also issue a rule under section 4(d) of the Act for the Neuse River waterdog, to provide for the conservation of this species. In addition, we designate critical habitat for both species under the Act. For the Carolina madtom, approximately 257 river miles (mi) (414 river kilometers (km)) fall within 7 units of critical habitat in Durham, Edgecombe, Franklin, Granville, Halifax, Johnston, Jones, Nash, Orange, Vance, Warren, and Wilson Counties, North Carolina. For the Neuse River waterdog, approximately 779 river mi (1,254 river km) fall within 18 units of critical habitat in Craven, Durham, Edgecombe, Franklin, Granville, Greene, Halifax, Johnston, Jones, Lenoir, Nash, Orange, Person, Pitt, Wake, Warren, Wayne, and Wilson Counties, North Carolina. This rule extends the Act’s protections to these species and their designated critical habitats. DATES: This rule is effective J (USFWS, 2021).

Critical Habitat Designation

Tar Population. Unit 1: TAR1—Upper Tar River Unit 1 consists of 12.3 miles (19.8 km) of the Tar River in Granville County from approximately SR1004 (Old NC 75) downstream to SR1622 (Cannady’s Mill Road). We revised Unit 1 to add 3.7 miles (6 km) of the Upper Tar River based on a 2018 observation of Neuse River waterdog provided by NCWRC. The riparian land adjacent to this unit is primarily privately owned (80 percent), with several conservation parcels or easements (20 percent). The unit contains all of the physical or biological features essential for the conservation of the species. Special management considerations or protection may be required within this unit to address a variety of threats. Excessive amounts of nitrogen and phosphorus run off the land, or are discharged, into the waters, causing excessive growth of vegetation and leading to extremely low levels of dissolved oxygen. Based on 2014 data, seven stream reaches totaling approximately 38 miles (61.1 km) are impaired in this basin. Indicators of impairment are low dissolved oxygen and low benthic-macroinvertebrate assessment scores, and the entire basin is classified as Nutrient Sensitive Waters (NCDEQ 2016, pp. 115–117). There are 102 non-major NPDES discharges, including several package WWTPs and biosolids facilities, and 3 major NPDES discharges (Oxford WWTP, Louisburg WWTP, and Franklin County WWTP) in this unit; with expansion of these facilities, or addition of new wastewater discharges, an additional threat to habitat exists in this unit. Special management focused on agricultural and forestry BMPs, implementing highest levels of wastewater treatment practicable, maintenance of forested buffers, and connection of protected riparian corridors will benefit habitat for the species in this unit (USFWS, 2021). Unit 2: TAR2—Upper Fishing Creek Unit 2 consists of 10.5 mi (16.9 km) of Upper Fishing Creek in Warren County. This unit extends from SR1118 (No Bottom Drive) downstream to NC58. The riparian land adjacent to the unit is primarily privately owned (94 percent) with several conservation parcels or easements (6 percent). This unit contains all of the physical or biological features essential for the conservation of the species. Special management considerations or protection may be required within this unit to address a variety of threats. Excessive amounts of nitrogen and phosphorus run off the land or are discharged into the waters, causing excessive growth of microscopic or macroscopic vegetation and leading to extremely low levels of dissolved oxygen. Special management focused on agricultural and forestry BMPs, maintenance of forested buffers, and connection of protected riparian corridors will benefit habitat for the species in this unit (USFWS, 2021). Unit 3: TAR3—Bens Creek Unit 3 consists of 2 miles (3.2 km) of Bens Creek in Warren County, North Carolina. The designated area begins approximately one mile upstream and ends approximately one mile downstream of SR1509 (Odell-Littleton Road). The addition of this unit is based on a 2019 observation of Neuse River waterdog provided by NCWRC. The riparian areas on either side of the river are privately owned. The unit contains all of the physical or biological features essential for the conservation of the species. Special management considerations or protection may be required to address excess sediment and pollutants that enter the creek and serve as indicators of other forms of pollution such as bacteria and toxins, reducing water quality for the species. Sources of these types of sediment and pollution are likely agricultural and silvicultural runoff. Special management focused on agricultural and forestry BMPs, maintenance of forested buffers, and connection of protected riparian corridors will benefit habitat for the species in this unit (USFWS, 2021). Unit 4: TAR4a—Fishing Creek Subbasin Revised Unit 4 consists of 82.8 miles (133.3 km) of lower Little Fishing Creek approximately 1.6 miles (2.6 km) upstream of SR1214 (Silvertown Rd) downstream to the confluence with Fishing Creek, and including the mainstem of Fishing Creek from the Warren/Halifax County line to the confluence with the Tar River in Edgecombe County. The revision of Unit 4 (previously Unit 3) adds 20 miles (32.3 km) of Fishing Creek based on a 2019 observation of Neuse River waterdog provided by NCWRC. The riparian land adjacent to the unit includes private land (86 percent), several conservation parcels (6 percent), and State game lands (8 percent). The unit contains all of the physical or biological features essential for the conservation of the species. Special management considerations or protection may be required within this unit to address a variety of threats. Excessive amounts of nitrogen and phosphorus run off the land, or are discharged, into the waters, causing excessive growth of vegetation and leading to extremely low levels of dissolved oxygen. Special management focused on agricultural and forestry BMPs, maintenance of forested buffers, and connection of protected riparian corridors will benefit habitat for the species in this unit (USFWS, 2021). Unit 5: TAR4b—Sandy/Swift Creek Unit 5 consists of an approximately 72.5 mi (116.8 km) segment of Sandy Creek downstream of SR 1451 (Leonard Road) to the confluence with the Tar River, including Red Bud Creek downstream of the Franklin/Nash county line to the confluence with Swift Creek. This unit is located in Warren, Franklin, Nash, and Edgecombe Counties. The riparian land adjacent to this unit includes private lands (97 percent), conservation parcels (1 percent), and State Game Lands (2 percent). This unit contains all of the physical or biological features essential for the conservation of the species. Special management considerations or protection may be required within this unit to address a variety of threats. Excessive amounts of nitrogen and phosphorus run off the land or are discharged into the waters, causing excessive growth of microscopic or macroscopic vegetation and leading to extremely low levels of dissolved oxygen; there is one ''impaired'' stream reach totaling approximately 5 miles (8 km) in this unit. Special management focused on agricultural and forestry BMPs, maintenance of forested buffers, and connection of protected riparian corridors will benefit habitat for the species in this unit (USFWS, 2021). Unit 6: TAR4c—Middle Tar River Subbasin Revised Unit 6 (previously Unit 5) consists of 111 miles (179 km) of the Middle Tar River from upstream of Highway 401 downstream to the confluence with Fishing Creek, including Stony Creek below SR1300 (Boddies' Millpond Rd), downstream to the confluence with the Tar River. This unit is located in Franklin, Nash, and Edgecombe Counties. We revised Unit 6 (previously Unit 5) to add 11 miles (17.8 km) of the upper reach of the Tar River based on a 2019 observation of Neuse River waterdog provided by a permitted private consultant. The riparian land adjacent to this unit is nearly all private lands (99 percent), with less than 1 percent conservation parcels, local parks, and a research station. The unit contains all of the physical or biological features essential for the conservation of the species. Special management considerations or protection may be required within this unit to address a variety of threats. Excessive amounts of nitrogen and phosphorus run off the land or are discharged into the waters, causing too much growth of microscopic or macroscopic vegetation and leading to extremely low levels of dissolved oxygen. As a result, there are six impaired stream reaches totaling approximately 32 miles in the unit. Expansion or addition of new wastewater discharges are also a threat to habitat in this unit. Special management focused on use of agricultural and forestry BMPs, implementation of highest levels of treatment of wastewater practicable, maintenance of forested buffers, and connection of protected riparian corridors will benefit habitat for the species in this unit (USFWS, 2021). Unit 7: TAR4d—Lower Tar River Subbasin Unit 7 consists of approximately 59.9 mi (96.3 km) in the Lower Tar River Subbasin from the confluence with Fishing Creek downstream to the confluence with Barber Creek near SR1533 (Port Terminal Road). This includes portions of Town Creek below NC111 to the confluence with the Tar River, Otter Creek below SR1251 to the confluence with the Tar River, and Tyson Creek below SR1258 to the confluence with the Tar River. This unit is located in Edgecombe and Pitt Counties. The riparian land adjacent to this unit consists of private land (97 percent), conservation parcels (2.5 percent), and State Game Lands (0.5 percent). This unit contains all of the physical or biological features essential for the conservation of the species. Special management considerations or protection may be required to address excess sediment and pollutants that enter the creek and serve as indicators of other forms of pollution such as bacteria and toxins, reducing water quality for the species. Special management focused on use of agricultural and forestry BMPs, implementation of highest levels of treatment of wastewater practicable, maintenance of forested buffers, and connection of protected riparian corridors will benefit habitat for the species in this unit (USFWS, 2021).

Neuse Population Unit 8: NR1—Eno River Unit 8 consists of approximately 43.9 mi (70.6 km) of the Eno River from NC86 downstream to the inundated portion of Falls Lake in Orange and Durham Counties. The riparian land adjacent to this unit includes private lands (61 percent), State Park Lands (25 percent), local government conservation parcels (12 percent), and State Game Lands (2 percent). This unit contains all of the physical or biological features essential for the conservation of the species. Special management considerations or protection may be required within this unit to address a variety of threats. Large quantities of nutrients (especially nitrogen) contributed by fertilizers and animal waste washed from lawns, urban developed areas, farm fields, and animal operations are impacting aquatic ecosystems in this unit. More than 300 permitted point-source sites discharge wastewater into streams and rivers in the basin. Development is also impacting areas along the Upper Neuse River. Special management considerations in this unit include using the highest available wastewater treatment technologies, retrofitting stormwater systems, eliminating direct stormwater discharges, increasing open space, maintaining connected riparian corridors, and treating invasive species (like hydrilla) (USFWS, 2021). Unit 9: NR2—Flat River Unit 9 is a 15.2-mi (24.5-km) segment of the Flat River from SR1739 (Harris Mill Road) downstream to the inundated portion of Falls Lake, located in Person and Durham Counties. The riparian land adjacent to this unit consists of some private land (49 percent) and extensive conservation parcels (51 percent), including demonstration forest, recreation areas, and State Game Lands. This unit contains all of the physical or biological features essential for the conservation of the species. Special management considerations or protection may be required within this unit to address a variety of threats. Large quantities of nutrients (especially nitrogen) contributed by fertilizers and animal waste washed from lawns, urban developed areas, farm fields, and animal operations are impacting aquatic ecosystems in this unit. Permitted point-source sites discharge wastewater into streams and rivers in the basin. Development is also impacting areas in the Upper Neuse River basin, including the Flat River. Special management considerations in this unit include using the highest available wastewater treatment technologies, retrofitting stormwater systems, eliminating direct stormwater discharges, increasing open space, maintaining connected riparian corridors, and treating invasive species (like hydrilla) (USFWS, 2021). Unit 10: NR3—Middle Creek Revised Unit 10 consists of 30.8 miles (49.6 km) of Middle Creek from Southeast Regional Park downstream to the confluence with Swift Creek in Wake and Johnston Counties, North Carolina. We revised Unit 10 to add 23.2 miles (37.4 km) of Middle Creek based on two 2018 observations of Neuse River waterdog provided by NCWRC. The riparian land adjacent to this unit is predominantly privately owned (91 percent) with a few conservation parcels, including the local park (9 percent). The unit contains all of the physical or biological features essential for the conservation of the species. Special management considerations or protection may be required within this unit to address a variety of threats. Large quantities of nutrients (especially nitrogen) contributed by fertilizers and animal waste washed from lawns, urban developed areas, and farm fields are impacting aquatic ecosystems in this unit. Several hundred permitted point-source sites discharge wastewater into streams and rivers in the basin. Development is also impacting areas in Middle Creek. Special management focused on use of agricultural and forestry BMPs, implementation of highest levels of treatment of wastewater practicable, maintenance of forested buffers, and connection of protected riparian corridors will benefit habitat for the species in this unit (USFWS, 2021). Unit 11: NR4—Swift Creek Unit 11 is a 24-mi (38.6-km) stretch of Swift Creek from NC42 downstream to the confluence with the Neuse River, located in Johnston County. The riparian land adjacent to this unit is entirely privately owned. This unit contains all of the physical or biological features essential for the conservation of the species. Special management considerations or protection may be required within this unit to address a variety of threats. Large quantities of nutrients (especially nitrogen) contributed by fertilizers and animal waste washed from lawns, urban developed areas, farm fields, and animal operations are impacting aquatic ecosystems in this unit. Several hundred permitted point-source sites discharge wastewater into streams and rivers in the basin. Development is also impacting areas throughout Swift Creek. Special management considerations in this unit include using the highest available wastewater treatment technologies, retrofitting stormwater systems, eliminating direct stormwater discharges, increasing open space, and maintaining connected riparian corridors (USFWS, 2021). Unit 12: NR5a—Little River Unit 12 is a 90.8-mi (146.1-km) segment of the Little River from near NC96 downstream to the confluence with the Neuse River, including Buffalo Creek from NC39 to the confluence with Little River, located in Franklin, Wake, Johnston, and Wayne Counties. The riparian land adjacent to this unit is predominantly privately owned (90 percent) with some (10 percent) local municipal conservation parcels (Little River Reservoir). This unit contains all of the physical or biological features essential for the conservation of the species. Special management considerations or protection may be required within this unit to address a variety of threats. Four stream reaches totaling approximately 17 miles are impaired in the Little River. The designation of impairment is based primarily on low benthic-macroinvertebrate assessment scores, low pH, and low dissolved oxygen. There are 32 non-major and no major NPDES discharges in this unit. Special management considerations in this unit include retrofitting stormwater systems, eliminating direct stormwater discharges, increasing and protecting existing open space, and maintaining connected riparian corridors (USFWS, 2021). Unit 13: NR5b—Mill Creek Unit 13 is a 20.8-mi (33.5-km) segment of Mill Creek from upstream of US701 downstream to the confluence with the Neuse River located in Johnston and Wayne Counties. The riparian land adjacent to this unit is predominantly privately owned (95 percent) with some conservation parcels (5 percent). This unit contains all of the physical or biological features essential for the conservation of the species. Special management considerations or protection may be required to address excess sediment and pollutants that enter the creek and serve as indicators of other forms of pollution such as bacteria and toxins, reducing water quality for the species. Special management focused on use of agricultural and forestry BMPs, implementation of highest levels of treatment of wastewater practicable, maintenance of forested buffers, and connection of protected riparian corridors will benefit habitat for the species in this unit (USFWS, 2021). Unit 14: NR5c—Middle Neuse River Unit 14 is a 43.2-mi (69.5-km) segment of the Middle Neuse River from the confluence with Mill Creek downstream to the Wayne/Lenoir County line, located in Wayne County. The riparian land adjacent to this unit includes privately owned land (92 percent), conservation parcels (0.95 percent), State Park land (7 percent), and the Seymour Johnson Air Force Base (0.05 percent). The 2 miles of river segment located on the land owned by the Air Force Base is exempt from critical habitat under section 4(a)(3) of the Act (see Exemptions, below). This unit contains all of the physical or biological features essential for the conservation of the species. Special management considerations or protection may be required within this unit to address a variety of threats. Large quantities of nutrients (especially nitrogen) contributed by fertilizers and animal waste washed from lawns, urban developed areas, farm fields, and animal operations are impacting aquatic ecosystems in this unit. More than 300 permitted point-source sites discharge wastewater into streams and rivers in the basin. Development is also impacting areas along the Middle Neuse River. Special management focused on use of agricultural and forestry BMPs, implementation of highest levels of treatment of wastewater practicable, maintenance of forested buffers, and connection of protected riparian corridors will benefit habitat for the species in this unit (USFWS, 2021). Unit 15: NR6—Contentnea Creek/Lower Neuse River Subbasin Unit 15 is an approximately 114.8-mi (184.8-km) reach, including Contentnea Creek from NC581 downstream to its confluence with the Neuse River, Nahunta Swamp from the Wayne/ Greene County line to the confluence with Contentnea Creek, and the Neuse River from the confluence with Contentnea Creek to the confluence with Pinetree Creek, located in Greene, Wilson, Wayne, Lenoir, Pitt, and Craven Counties. The riparian land adjacent to this unit is nearly all privately owned land (99 percent), with <1 percent conservation parcels. This unit contains all of the physical or biological features essential for the conservation of the species. Special management considerations or protection may be required within this unit to address a variety of threats. Two stream reaches totaling approximately 21 miles are impaired in Contentnea Creek, with 55 impaired stream miles in the entire unit. The designation of impairment is based primarily on low benthic macroinvertebrate assessment scores, low pH, and low dissolved oxygen. There are 9 major and 195 non-major NPDES discharges in this unit. Special management considerations in this unit include retrofitting stormwater systems, eliminating direct stormwater discharges, increasing and protecting existing open space, and maintaining connected riparian corridors (USFWS, 2021). Unit 16: NR7—Swift Creek (Lower Neuse) Unit 16 is a 10.3-mi (16.5-km) reach of Swift Creek from SR1931 (Beaver Camp Rd) downstream to SR1440 (Streets Ferry Rd) located in Craven County. The riparian land adjacent to this unit is nearly all privately owned (99 percent) with some conservation parcels (1 percent). This unit contains all of the physical or biological features essential for the conservation of the species. Special management considerations or protection may be required to address excess sediment and pollutants that enter the creek and serve as indicators of other forms of pollution such as bacteria and toxins, reducing water quality for the species. Special management focused on use of agricultural and forestry BMPs, implementation of highest levels of treatment of wastewater practicable, maintenance of forested buffers, and connection of protected riparian corridors will benefit habitat for the species in this unit (USFWS, 2021).

Trent Population Unit 17: TR1—Trent River Revised Unit 17 consists of 32.5 miles (52.4 km) of Beaver Creek from SR1316 (McDaniel Fork Rd) to the confluence with the Trent River, and Trent River from the confluence with Poplar Branch downstream to the SR1121 (Oak Grove Rd) crossing at the Marine Corps Cherry Point property, in Jones County. This unit was decreased to not include land owned by the Marine Corps at its Air Station (MCAS) Cherry Point Oak Grove Outlying Landing Field. The base's integrated natural resources management plan (INRMP) includes implementing ecosystem management practices that support the conservation and management of at-risk herpetofauna species, including Neuse River waterdog, known to occur at MCAS Cherry Point (Tetra Tech 2012, p. C–10). The riparian land adjacent to this unit is privately owned. This unit contains all of the physical or biological features essential for the conservation of the species. Special management considerations or protection may be required to address excess sediment and pollutants that enter the river and serve as indicators of other forms of pollution such as bacteria and toxins, reducing water quality for the species. Special management focused on use of agricultural and forestry BMPs, implementation of highest levels of treatment of wastewater practicable, maintenance of forested buffers, and connection of protected riparian corridors will benefit habitat for the species in this unit (USFWS, 2021). Unit 18: TR2—Tuckahoe Swamp Unit 18 consists of 2 miles (3.2 km) of Tuckahoe Swamp in Jones County, North Carolina. The designated area begins upstream of SR1142 (Weyerhaeuser Road) to the confluence with the Trent River. The riparian areas on either side of the river are privately owned. This unit contains all of the physical or biological features essential for the conservation of the species. Special management considerations or protection may be required to address excess sediment and pollutants that enter the river and serve as indicators of other forms of pollution such as bacteria and toxins, reducing water quality for the species. Special management focused on use of agricultural and forestry BMPs, implementation of highest levels of treatment of wastewater practicable, maintenance of forested buffers, and connection of protected riparian corridors will benefit habitat for the species in this unit (USFWS, 2021).

Primary Constituent Elements/Physical or Biological Features

We have determined that the following physical or biological features are essential to the conservation of Neuse River waterdog: (1) Suitable substrates and connected instream habitats, characterized by geomorphically stable stream channels and banks (i.e., channels that maintain lateral dimensions, longitudinal profiles, and sinuosity patterns over time without an aggrading or degrading bed elevation) with habitats that support a diversity of native aquatic fauna (such as stable riffle-run-pool habitats that provide flow refuges consisting of siltfree gravel, small cobble, coarse sand, and leaf litter substrates) as well as abundant cover and burrows used for nesting. (2) Adequate flows, or a hydrologic flow regime (which includes the severity, frequency, duration, and seasonality of discharge over time), necessary to maintain instream habitats where the species is found and to maintain connectivity of streams with the floodplain, allowing the exchange of nutrients and sediment for maintenance of the waterdog's habitat, food availability, and ample oxygenated flow for spawning and nesting habitat. (3) Water quality (including, but not limited to, conductivity, hardness, turbidity, temperature, pH, ammonia, heavy metals, and chemical constituents) necessary to sustain natural physiological processes for normal behavior, growth, and viability of all life stages. (4) Invertebrate and fish prey items, which are typically hellgrammites, crayfish, mayflies, earthworms, snails, beetles, centipedes, slugs, and small fish (USFWS, 2021).

Life History

Food/Nutrient Resources

Food Source

Adult: adults eat larger aquatic arthropods and also any aquatic and terrestrial invertebrates (including hellgrammites, mayflies, caddisflies, crayfish, beetles, caterpillars, snails, spiders, earthworms, centipedes, millipedes, slugs) and some vertebrates (including small fish like darters and pirate perch) (Bury 1980, p.16; Braswell and Ashton 1985, p.23). All prey are ingested whole, and larger items are sometimes regurgitated and then re-swallowed (USFWS, 2018).

Lifespan

Adult: Longevity of Neuse River Waterdogs is not known, however its close relative N. maculosus may live for 30+ years (McDaniel et al. 2009, p.182) (USFWS, 2018).

Breeding Season

Adult: mating in the fall/winter (USFWS, 2018)

Reproduction Narrative

Adult: Neuse River Waterdogs reach sexual maturity at around 5.5-6.5 years, or at a length of 102 mm (~4 inches) SVL (snout-vent length) for males and 100 mm SVL for females (Fedak, 1971). The sexes are similar in appearance and can be distinguished only by the shape and structure of the cloacal area. Neuse River Waterdogs breed once per year, with mating in the fall/winter and spawning in the spring (Pudney et al. 1985, p.54). After courtship, the male will deposit a packet of sperm which the female places into her vent, thus fertilization occurs internally (Pudney et al. 1985, p.54). During the spring (May-June), females will lay a clutch of ~25-90 eggs in a rudimentary nest, under large rocks in moderate currents (Cooper and Ashton 1985, p.5). Ashton (1985, p.95) noted that nest sites were often found under large bedrock outcrops or large boulders with sand and gravel beneath them, often placed there by the waterdogs. Females guard the nest (Braswell 2005, p.868) (USFWS, 2018).

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2018)

Habitat Narrative

Adult: The Neuse River Waterdog is endemic to the Neuse and Tar drainages of North Carolina. They are distributed from larger headwater streams in the Piedmont to coastal streams up to the point of saltwater intrusion, and none have been found in lakes or ponds (Braswell and Ashton 1985, p.13). Braswell and Ashton (1985, p.13) noted that waterdogs are usually found in streams wider than 15m (although some have been observed in smaller creeks (S.McRae, USFWS, pers. obs.), deeper than 100cm, and with a main channel flow rate greater than 10cm/sec. Further, these stream salamanders need clean, flowing water characterized by high dissolved oxygen concentrations (Brimley 1924, p.168; Braswell and Ashton 1985, p.13; Ashton 1985, p.103). The preferred habitats vary with the season, temperature, dissolved oxygen content, flow rate and precipitation (Ashton 1985, p.103), however the waterdogs do maintain home retreat areas under rocks, in burrows, or under substantial cover in backwater or eddy areas (USFWS, 2018).

Dispersal/Migration

Population Information and Trends

Resiliency:

As a species, the Neuse River Waterdog has limited resiliency, with one population in moderate condition, and two populations in low condition (USFWS, 2018).

Representation:

The Neuse River Waterdog has exhibited historical variability in the physiographic regions it inhabited, as well as the size and range of the river systems it inhabited. The species has been documented from medium streams to large rivers in two physiographic provinces, in the Piedmont and into the Coastal Plain. Some of the representation of the Neuse River Waterdog has been lost; physiographic variability has been lost with 13% loss in the Coastal Plain and 43% loss in the Piedmont (USFWS, 2018).

Redundancy:

The Neuse River Waterdog historically has a narrow endemic range in the Tar-Pamlico River and the Neuse River (including the Trent River) basins in North Carolina, but both the number and distribution of waterdogs occupying that historical range has declined over the past 40 years (USFWS, 2018).

Number of Populations:

3 (USFWS, 2021)

Threats and Stressors

Stressor: Development & Pollution
Exposure:
Response:
Consequence:
Narrative: Urban development can lead to increased variability in streamflow, typically increasing the amount of water entering a stream after a storm and decreasing the time it takes for the water to travel over the land before entering the stream (Giddings et al. 2009, p.1). In

urban areas, flooding is often reduced by draining water quickly from roads and parking lots which results in increased amounts of water reaching a stream within a short period of time, leading to stream flashiness and altered stream channels (Giddings et al. 2009, p.1). The rapid runoff also reduces the amount of infiltration into the soil to recharge aquifers, resulting in lower sustained streamflows, especially during summer (Giddings et al. 2009, p.1). Ultimately, when the hydrology of the stream is altered and water quantities vary widely, the physical habitat of a stream often becomes degraded from channel erosion or lower summer flows that ultimately reduces feeding, spawning, and living spaces of the Neuse River Waterdog and other aquatic biota living in the streams (Giddings et al. 2009, p.1). Urban development can alter stream habitat either directly via channelization or clearing of riparian areas, or indirectly via high streamflows that reshape the channel and cause sediment erosion (Giddings et al. 2009, p.2) (USFWS, 2018).

Stressor: Agricultural Practices
Exposure:
Response:
Consequence:
Narrative: Farming operations can contribute to nutrient pollution when not properly managed (USEPA 2016, entire). Fertilizers and animal manure, which are both rich in nitrogen and phosphorus, are the primary sources of nutrient pollution from agricultural sources. If fertilizers are not applied in the proper amount, at the right time of the year and with the right application method, water quality in the stream systems can be affected. Excess nutrients impact water quality when it rains or when water and soil containing nitrogen and phosphorus wash into nearby waters or leach into the water table/ground waters. Fertilized soils and livestock can be significant sources of nitrogen-based compounds like ammonia and nitrogen oxides. Ammonia can be harmful to aquatic life if large amounts are deposited to surface waters. Agricultural pesticide use can also have detrimental effects, and studies have shown the species to have low to moderate levels of pesticide contamination from a variety of sources, including insect control (Aktar et al. 2009, p.5). The lack of stable stream bank slopes from agricultural clearing and/or the lack of stable cover crops between rotations on farmed lands can increase the amount of nutrients that make their way into the nearby streams by way of increased soil erosion (cover crops and other vegetation will use excess nutrients and increase soil stability). Livestock often use streams or created inline ponds as a water source; this degrades water quality and stream bank stability and reduces water quantity available for downstream needs. Pumping for Irrigation Irrigation is the controlled application of water for agricultural purposes through manmade systems to supply water requirements not satisfied by rainfall. It is common practice to pump water for irrigation from adjacent streams or rivers into a reservoir pond, or sprayed directly onto crops. If the water withdrawal is excessive (usually over 10,000 gal/day) or done illegally (without permit if needed, or during dry time of year, or in areas where sensitive aquatic species occur without consultation), this may cause impacts to the amount of water available to downstream sensitive areas during low flow months, thus potentially resulting in dewatering of channels and displacement of aquatic salamanders. Agriculture Exemptions from Permit Requirements Normal farming, silviculture, and ranching activities are exempt from the 404 permitting process. This includes activities such as construction and maintenance of farm ponds, irrigation ditches, and farm roads. If the activity might impact rare aquatic species, the US ACE does require farmers to ensure that any “discharge shall not take, or jeopardize the continued existence of, a threatened or endangered species, or adversely modify or destroy the critical habitat of such species”, and to ensure that “adverse impacts to the aquatic environment are

minimized", however the USACE does not require the farmer to consult with appropriate State or Federal Agencies regarding these sensitive species. While there is an expectation for farmers to follow best management practices (BMPs), there are often cases where BMPs are not followed and go un-noticed as many farming activities are in rural locations and regulators are spread thin (E.Wells (USFWS) email to S.McRae (USFWS) on 5/13/2016). Confined Animal Feeding Operations Confined Animal Feeding Operations (CAFOs) and feedlots can cause degradation of aquatic ecosystems, primarily because of manure management issues (Burkholder et al. 2007, p.308). CAFOs hold tens of thousands of animals and produce a large amount of waste which enters the environment either by being discharged directly into streams or constructed ditches, stored in open lagoons, or applied to fields in wet or dry form (as referenced by Buckner et al. 2002, Mallin and Cahoon 2003, and Orlando 2004 in CBD 2010, p.18). CAFO wastes contain nutrients, pharmaceuticals, and hormones, and cause eutrophication of waterways, toxic blooms of algae and dinoflagellates, and endocrine disruption in downstream wildlife (Mallin and Cahoon 2003, p.369; Orlando et al. 2004, p.353; Burkholder et al. 2007, pp.308-309; Harden 2015, p.2) (USFWS, 2018).

Stressor: Forest Conversion and Management
Exposure:
Response:
Consequence:
Narrative:

Stressor: Invasive Species
Exposure:
Response:
Consequence:
Narrative:

Stressor: Dams and Barriers (Natural System Modifications)
Exposure:
Response:
Consequence:
Narrative:

Stressor: Energy Production and Mining
Exposure:
Response:
Consequence:
Narrative:

Stressor: Regulatory Mechanisms
Exposure:
Response:
Consequence:
Narrative:

Stressor: Climate Change
Exposure:

Response:
Consequence:
Narrative:

Recovery

Reclassification Criteria:
Recovery Priority Number: 11C

Recovery Actions:

- Conservation management actions include in situ actions such as habitat protection and stream restoration as well as ex situ actions such as captive propagation, ultimately leading to species population restoration. “It is…widely recognized that the future of rare aquatic species is best secured by protecting and restoring biological integrity of entire watersheds” (Shute et al. 1997, p.448 and references therein). While land acquisition is the most obvious means of affecting watershed protection, it is not feasible to acquire entire watersheds. Shute et al. (1997, p.448) offer up “Ecosystem Management” as the most effective method of protecting the greatest number of species, however, they warn that “the complex nature of aquatic ecosystems and the watershed scale necessary for aquatic ecosystem protection is problematic... [It] is expensive, time consuming, and requires considerable coordination with and commitment from various agencies, organizations, and private individuals.” The Service and State Wildlife Agencies are working with numerous partners to make “Ecosystem Management” a reality, primarily by providing technical guidance and offering development of conservation tools to meet both species and habitat needs in aquatic systems in North Carolina. Land Trusts are targeting key parcels for acquisition, federal, state, and University biologists are surveying and monitoring species occurrences, and recently there has been increased interest in efforts to ramp up captive propagation and species population restoration via augmentation, expansion, and reintroduction efforts (USFWS, 2018).
- Recovery Priority Number A Recovery Priority Number reflects the degree of threat to a species, its recovery potential, its taxonomy, and the potential for conflict. The Neuse River Waterdog is assigned a recovery priority of 11C, reflecting a moderate degree of threat, low recovery potential, and the potential for conflict with construction or development projects, or other forms of economic activity within its range. The degree of threat is moderate because the species is not facing immediate extinction, but populations have declined and threats to its habitat are ongoing. For recovery potential, biological and ecological limiting factors of the Neuse River Waterdog and its threats are fairly well understood. However, because threats to the species and habitat are pervasive and difficult to alleviate (i.e., watershed-level effects that degrade habitat and water quality), its recovery potential is considered low. (USFWS, 2021a)

Conservation Measures and Best Management Practices:

- Permits to fill wetlands and fill, culvert, bridge or re-align streams/water features are issued by the U.S. Corps of Engineers under Nationwide, Regional General Permits or Individual Permits. ● Nationwide Permits are for “minor” impacts to streams and wetlands, and do not require an intense review process. These impacts usually include stream impacts under 150 feet, and wetland fill projects up to 0.50 acres. Mitigation is usually provided for the same type of wetland or stream as what is impacted, and is usually at a 2:1 ratio to offset losses and make the “no net loss” closer to reality. ● Regional General Permits are for various specific types of impacts that are common to a particular region; these permits will vary based on location in a certain region/state. ● Individual permits are for the larger, higher impact and more complex projects. These require a complex permit process with multi-agency input and involvement. Impacts in these types of permits are reviewed individually and the compensatory mitigation chosen may vary depending on project and types of impacts. (USFWS, 2021)

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U.S. Fish and Wildlife Service. 2018. Species status assessment report for the Neuse River Waterdog (Necturus lewisi). Version 1.1. November, 2018. Atlanta, GA. U.S. Fish and Wildlife Service. 2021. Endangered and Threatened Wildlife and Plants

Threatened Species Status With Section 4(d) Rule for Neuse River Waterdog, Endangered Species Status for Carolina Madtom, and Designations of Critical Habitat. Final Rule. FR Vol. 86, No. 109. Pages 30688-30751.

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USFWS. 2021a. Recovery Outline for Neuse River Waterdog (Necturus lewisi). 9 pp.

USFWS. 2021. Species status assessment report for the Neuse River Waterdog (Necturus lewisi). Version 1.2. February, 2021. Atlanta, GA.

SPECIES ACCOUNT: *Rana boylii* (Foothill yellow-legged frog)

Species Taxonomic and Listing Information

Listing Status: Endangered

Physical Description

the foothill yellow-legged frog is a small- to mediumsized (37 to 82 millimeters (mm) (1.5 to 3.2 inches (in.)) snout-urostyle length (SUL)) frog with indistinct dorsolateral folds, fully webbed feet, and rough pebbly skin. Dorsal color is highly variable and is usually light and dark mottled gray, olive, or brown, with variable amounts of brick red. The undersurfaces of the posterior abdomen and ventral surfaces of the rear legs are varying shades of yellow. The foothill yellow-legged frog is sexually dimorphic with females attaining larger sizes than males, and mature males having a dark swollen bump on the dorsomedial surface of each thumb, proportionally larger forearm muscles, and narrower waists. Juvenile foothill yellow-legged frogs are similar to adults except for their smaller size (14 to 36 mm (0.5 to 1.4 in.) SUL) more contrasting dorsal coloration, and lack of significant yellow on their undersurfaces (reviewed in Hayes et al. 2016, p. 4). Tadpoles can be distinguished from tadpoles of co-occurring species by the greater number (five or more) of rows of teeth in the upper and lower jaw (USFWS, 2023).

Taxonomy

The foothill yellow-legged frog retains its classification as Rana boylii, ascribed in 1854 by S.F. Baird (Baird 1854, p. 62; Frost 2019, not paginated). In 1955, the R. boylii (formerly spelled “boylei”) group was comprised of six Rana boylii subtaxa but were then split into six discrete taxa by Zweifel (1955, pp. 210, 273). The foothill yellow-legged frog is now the only entity classified as Rana boylii and the taxon is not subdivided into subtaxa (Zweifel 1968, pp. 71.1–71.2). However, this taxon continues to be the focus of genetic research, which has recently demonstrated that the foothill yellow-legged frog has deeper population structure than that observed in any anuran with similar data (McCartney-Melstad et al. 2018, p. 112). The California Department of Fish and Wildlife (CDFW) recently classified this species as having six unique, genetic clades (i.e., lineages) (USFWS, 2023)

Current Range

Coast Range from Coastal Monterey County south to Los Angeles County)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food Source

Juvenile: Juvenile and adult foothill yellowlegged frogs prey upon many types of aquatic and terrestrial invertebrates including snails, moths, flies, water striders, beetles, grasshoppers, hornets, and ants (USFWS, 2023).

Adult: Ranid species do not typically have specific food preferences in the adult life stage and feed upon a wide range of arthropods, small fish, and small frogs (Zweifel 1955, p. 223). Cannibalism has also been observed in the foothill yellow-legged frog under laboratory conditions (Zweifel 1955, p. 223). Juvenile and adult foothill yellowlegged frogs prey upon many types of aquatic and terrestrial invertebrates including snails, moths, flies, water striders, beetles, grasshoppers, hornets, and ants The arthropods identified from stomach contents (in the North Sierra unit) were predominantly insects (88 percent), followed by arachnids (12 percent) (van Wagner 1996, p. 89). Similarly, the stomach contents were primarily terrestrial (88 percent), as opposed to aquatic (i.e., captured on or under water) (USFWS, 2023).

Reproductive Strategy

Adult: Oviparity

Lifespan

Adult: Max. age between 11-13 years (USFWS, 2023)

Breeding Season

Adult: Breeding takes place between late March and early July (USFWS, 2023)

Other Reproductive Information

Adult: During the breeding season, foothill yellow-legged frogs exhibit a lek-style mating system, where males congregate at breeding sites and often establish small calling territories to attract female mates (Wheeler and Welsh 2008, pp. 137–138). Several types of vocalizations are made by male foothill yellow-legged frogs, primarily underwater (MacTague and Northen 1993, p. 1; Silver 2017, p. 33). The diversity of calls suggests that vocalizations are used for more than just mate attraction (MacTague and Northen 1993, p. 1). An underwater duet between a male and female foothill yellow-legged frog in amplexus (i.e., the mating position) has also been recorded (Silver 2017, p. 33). A study of vocalizations from foothill yellow-legged frog populations in three California counties (Mendocino, Butte, and Alameda counties) showed significant regional variation in dialect (USFWS, 2023).

Reproduction Narrative

Egg: Egg masses require a narrow range of microsite conditions for successful hatching (Kupferberg 1996a, p. 1336; Lind et al. 2016, p. 263). Embryonic development is highly temperature dependent (Hayes et al. 2016, p. 14). Hatching may take anywhere from approximately 5 days at 20 °C (68 °F) (Zweifel 1955, p. 229) to 36 days (pers. obs. cited in Hayes et al. 2016, p. 15). Oviposition microsites have shallow water depths and slow water velocities when compared to ambient conditions (Kupferberg 1996a, p. 1336; Wheeler et al. 2006, p. 7; Bondi et al. 2013, p. 93). Substrate (i.e., streambed surface material) also plays a critical role in oviposition site selection, with most egg masses being attached to cobblestones and/or the downstream side of rocks (Storer 1925, p. 253; Kupferberg 1996a, p. 1336). Under ideal conditions, hatching success is approximately 83 percent and does not appear to vary across the species' range (USFWS, 2023).

Larvae: The tadpole (larval) stage (Figure 7), from hatching to metamorphosis (Gosner stages approximately 21 to 41 (Gosner 1960, entire)), may last from approximately 7 weeks (Wheeler et al. 2015, p. 1280) to four months (Storer 1925, p. 255; Catenazzi and Kupferberg 2013, p. 46). Time from hatching to metamorphosis varies; tadpoles reach metamorphosis more quickly as temperature and algal food availability increase (Kupferberg et al. 2011a, entire; Catenazzi and Kupferberg 2013, p. 46). Unless disturbed, newly hatched tadpoles remain with the egg mass for several days (Ashton et al. 1997, pp. 7, 9) (Figure 8). After this, young tadpoles disperse short distances and begin using interstitial spaces in the stream substrate for shelter (Ashton et al. 1997, p. 9). Under sub-optimal conditions, tadpoles remain in this vulnerable life stage for longer, which increases risk of mortality. Furthermore, tadpoles may fail to undergo, or complete metamorphosis prior to fall/winter flows, which can cause mortality because foothill yellowlegged frogs do not have morphological adaptations that would allow them to withstand high water-velocity conditions (Kupferberg et al. 2009c, p. 6). In temperature-controlled laboratory experiments, tadpoles from Sierra Nevadan populations demonstrated a capacity for faster growth and development than tadpoles from coastal populations (USFWS, 2023).

Juvenile: Juvenile foothill yellow-legged frogs (Figure 10) are post-metamorphic frogs that have not yet developed sexual reproductive characteristics. Juveniles are typically less than 40 mm (1.6 in.) SUL, with females maturing at a larger size than males (Kupferberg et al. 2009c, p. 34). Juveniles can remain active and grow during the winter (Rombough 2006b, p. 159), but grow very little (Storer 1925, pp. 255–256). During the breeding season following metamorphosis, wild juvenile frogs (i.e., yearlings) are still smaller than adults and do not breed (Storer 1925, p. 256; Zweifel 1955, p. 229). In most populations, female foothill yellow-legged frogs begin reproductive activity during their third spring post-metamorphosis; however, evidence suggests that in some central coast populations, females breed during their second spring (USFWS, 2023).

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Habitat Type

Adult: wide variety of vegetation types including valley-foothill hardwood, valley-foothill hardwood-conifer, valley-foothill riparian, ponderosa pine, mixed conifer, mixed chaparral, and wet meadow (USFWS, 2023).

Spatial Arrangements of the Population

Adult: Clumped

Environmental Specificity

Adult: Narrow

Tolerance Ranges/Thresholds

Adult: Moderate

Site Fidelity

Adult: Moderate

Habitat Narrative

Adult: The foothill yellow-legged frog is a stream-obligate species that typically occurs from sea level to approximately 1,524 m (5,000 ft) (pers. comm. cited in CDFW 2019b, p. 8). The foothill yellow-legged frog occurs in a wide variety of vegetation types including valley-foothill hardwood, valley-foothill hardwood-conifer, valley-foothill riparian, ponderosa pine, mixed conifer, mixed chaparral, and wet meadow (Hayes et al. 2016, p. 5). The extensive range of the foothill yellow-legged frog demonstrates the species' non-specificity in regards to vegetation type and macroclimate of the species' terrestrial habitat component. Foothill yellow-legged frogs are primarily observed in or along the edges of streams (Zweifel 1955, p. 221; Kupferberg 1996a, p. 1339). Most foothill yellow-legged frogs breed along mainstem water channels and overwinter along smaller tributaries of the mainstem channel (Kupferberg 1996a, p. 1339; GANDA 2008, p. 20). Stream morphology is a strong predictor of breeding habitat because it creates the microhabitat conditions required for successful oviposition (i.e., egg-laying), hatching, growth, and metamorphosis. Foothill yellow-legged frogs that overwinter along tributaries often congregate at the same breeding locations along the mainstem each year (Kupferberg 1996a, p. 1334; Wheeler and Welsh 2008, p. 128). During the non-breeding season, the smaller tributaries, some of which may only flow during the wet winter season, provide refuge while the larger breeding channels may experience overbank flooding and high flows (Kupferberg 1996a, p. 1339). Habitat elements that provide both refuge from winter peak flows and adequate moisture for foothill yellow-legged frogs include pools, springs, seeps, submerged root wads, undercut banks, and large boulders or debris at high-water lines (USFWS, 2023). Foothill yellow-legged frogs appear to use different overwintering strategies in terms of seasonal movement and habitat type, even within a single population (Bourque 2008, p. 65). Generally, foothill yellow-legged frogs travel up along small tributaries where they become inactive for a period during the winter. However, foothill yellow-legged frogs may remain active during the winter if conditions are favorable (van Wagner 1996, pp. xix, 74). The foothill yellow-legged frog inactive period is variable among years and by geography, climate, and life stage. The inactive period, if it occurs at all, typically extends from mid-fall until late February or early March, with adults remaining inactive for longer periods than juveniles (Zweifel 1955, p. 226). Activity may begin earlier during mild winters and active individuals have been observed throughout the winter in the San Francisco Bay area (Zweifel 1955, p. 226). Compared to higher elevation populations, coastal populations and those in lower-elevations of the Sierra Nevada might be active for an extra month in the fall and extra month in the late winter; in the highest range elevations, the inactive period may be four or five months long (USFWS, 2023).

Dispersal/Migration

Dispersal

Adult: juvenile frogs were found dispersing into a residential neighborhood 16 to 331 m (52 to 1,086 ft) from the creek (USFWS, 2023)

Dispersal/Migration Narrative

Adult: In Mendocino County (North Coast California unit), juvenile frogs were found dispersing into a residential neighborhood 16 to 331 m (52 to 1,086 ft) from the creek (Cook et al. 2012, p. 325). In Tehama County (North Coast California unit), a radio-telemetered female traveled approximately 7 km (4.3 mi), using intermittent tributaries (some of which were dry with only moist substrates) and cresting a ridge (Bourque 2008, p. 30). Bourque (2008, p. 72) noted that adults at the Tehama County study site typically moved during hot and dry conditions but avoided desiccation by restricting travel routes to drainage networks with moist substrates (USFWS, 2023).

Population Information and Trends

Population Trends:

Declining (USFWS, 2023)

Number of Populations:

4 listed populations

Population Narrative:

Subpopulations are subject to periodic extirpation from demographic or environmental stochasticity, but then are naturally repopulated via colonization from nearby subpopulations. Therefore, it is more informative to look at species' status at the metapopulation level, which is more stable than the subpopulation level. A metapopulation is distinguished from an adjacent metapopulation by the rate of gene flow, with gene flow and recolonization rates being greater within a single metapopulation than between adjacent metapopulations. Given this definition, we can deduce that each of the six foothill yellow-legged frog genetic clades (2.6 Genetic Clades) contains one or more metapopulations that are unique to that clade. Often, metapopulations are separated by large distances (greater than typical dispersal distances) and/or unsuitable habitat, or by topological features that act as barriers to dispersal. Although there is information about distances moved by marked frogs (up to 1000's of m (Bourque 2008, p. 30; Gonsolin 2010, p. 38)) and the distances at which genetic differentiation can be observed (10 km (6.2 mi) (Dever 2007, p. 171;)), the actual boundaries of foothill yellow-legged frog metapopulations are largely unknown. Population models demonstrate how foothill yellow-legged frog population abundance can have a sizeable effect on extirpation probability (Kupferberg et al. 2009c, p. ix; Rose et al. 2021, p. 12, figure 5). However, the minimum abundance required for a foothill yellow-legged frog population to be viable (i.e., minimum viable population) over an extended period is unknown. Multi-year survey data show how the average abundance of breeding females per km varies drastically among populations (Rose et al. 2020, pp. 63–64, table 1). The highest abundances (>100 breeding females per km) have only been recorded in the North Coast California unit (Rose et al. 2020, pp. 63–64, 76, table 1, figure 4). One of the most abundant foothill yellowlegged frog populations is along the Mad River (Humboldt County, North Coast California unit) where the average breeding female density was 259 per km for 2008–2019 (Green Diamond Resource Company 2020, in litt.). Egg mass abundance (i.e., proxy for number of breeding females) peaked in 2017 when 1,469 egg masses were counted within a 2.35 km stretch of the Mad River during a single survey (Green Diamond Resource Company 2020, in litt.). There are also populations that have exhibited long-term stability with much lower abundances, such as 18 breeding females per km, in some Central Coast unit streams (Rose et al. 2020, pp. 63, 76, table 1, figure 4). Locations where breeding female abundances are much lower (e.g., 5 per km) could be population sinks where female emigrants from nearby populations lay eggs but recruitment typically fails due to poor spawning and rearing conditions (USFWS, 2023).

Threats and Stressors

Stressor: Altered hydrology
Exposure:
Response:
Consequence:
Narrative: Dams and other waterway modifications alter the hydrology, temperature, and morphology of foothill yellow-legged frog stream habitat.

Stressor: Nonnative species
Exposure:
Response:
Consequence:
Narrative: Foothill yellow-legged frog viability can be negatively influenced by several nonnative animal species. The American bullfrog (Lithobates catesbeianus, also known as Rana catesbeiana), nonnative crayfish (Pacifastacus spp.), and nonnative fish (e.g., smallmouth bass (Micropterus dolomieu)) have all been linked to decreases in foothill yellow-legged frogs (Olson and Davis 2009, pp. 17–18; Hayes et al. 2016, pp. 49–51). The following subsections provide details on how these nonnative species influence the foothill yellow-legged frog at various life stages by increasing predation, competition, and/or disease transmission. Other nonnative species, such as the barred owl (Strix varia), might also negatively influence foothill yellow-legged frog viability but are not discussed in detail because of limited information. Barred owls are suspected to be an emerging threat to foothill yellow-legged frogs in the North Coast analysis units (D. Olson 2021, in litt.) because of their predation of ranid frogs.

Stressor: Disease and parasites
Exposure:
Response:
Consequence:
Narrative: Foothill yellow-legged frog viability can be negatively influenced by the presence of Batrachochytrium dendrobatidis (Bd; causative agent of chytridiomycosis), parasitic copepods, and water molds (Saprolegniaceae family).

Stressor: Sedimentation
Exposure:
Response:
Consequence:

Narrative: Sedimentation is a threat for foothill yellow-legged frogs because it reduces the availability of important habitat features including coarse rocky substrates, geomorphic heterogeneity, and interstitial spaces. Increased sedimentation can increase turbidity, impact food resources, or impede foothill yellow-legged frog egg mass attachment to substrate (Cordone and Kelley 1961, pp. 191–192; Ashton et al. 1997, p. 13). Fine sediments can also fill interstitial spaces between rocks, which provide shelter from high velocity flows, cover from predators, and sources of aquatic invertebrate prey.

Stressor: Agriculture
Exposure:
Response:
Consequence:
Narrative: Agriculture is a source of threats to the foothill yellow-legged frog because of agriculture's role in habitat degradation, contribution of pesticides and pollutants to the environment, and role as a driver of other threats such as altered hydrology and nonnative species (Figure 26). Agricultural land uses have been linked to declines in foothill yellow-legged frog populations (Davidson et al. 2002, p. 1597; Lind 2005, pp. 19, 51, 62, table 2.2). Foothill yellow-legged frog presence is negatively associated with agriculture within 5 km (3.1 mi).

Stressor: Mining
Exposure:
Response:
Consequence:
Narrative: Mining is a source of threats to the foothill yellow-legged frog because of its role in habitat destruction and degradation, pollution, and expansion of nonnative species (Figure 29). Several types of mining practices have negatively affected foothill yellow-legged frog habitat; these include aggregate, hard-rock, hydraulic, and suction-dredge mining.

Stressor: Urbanization, Roads, and Recreation
Exposure:
Response:
Consequence:
Narrative: Urbanization, roads, and recreation can affect foothill yellow-legged frog viability directly through mortality, but they are also major sources of threats to the foothill yellow-legged frog because of their role in habitat destruction, degradation, and fragmentation; contribution of pesticides and pollutants to the environment; and their role as drivers of other threats such as altered hydrology, nonnative species, and disease transmission (Figure 30). Conversion or alteration of natural habitats for urban land uses has been linked to declines in foothill yellowlegged frog populations (Davidson et al. 2002, p. 1597; Lind 2005, pp. 19, 51, 62, table 2.2). Foothill yellow-legged frog presence is negatively associated with cities and road density (Davidson et al. 2002, p. 1594; Olson and Davis 2009, p. 22). Increases in urbanization and roads have been reportedly associated with foothill yellow-legged frog extirpations in the South Coast unit, possibly by facilitating the spread of Bd and nonnative species.

Stressor: Drying and Drought
Exposure:
Response:
Consequence:

Narrative: Temporary drying of waterways (from anthropogenic water allocation and/or drought) is implicated in declines and extirpations of foothill yellow-legged frogs because it shortens the hydroperiod; negatively affects habitat elements that are hydrology-dependent; limits recruitment, survival, and connectivity; and exacerbates the effects of other threats (Figure 33, Figure 34). Periodic drying of waterways and/or drought occurs naturally in foothill yellowlegged frog habitat, particularly in the southern analysis units (South Sierra, Central Coast, and South Coast units) (Adams et al. 2017b, p. 10227), but frequency of drying and drought is increasing because of anthropogenic water use and the effects of climate change (Section 7.13). Breeding sites that completely dried during consecutive severe drought years had zero reproductive success (S. Kupferberg, pers. comm. cited in Wheeler et al. 2018, p. 296; M. Parker 2021, in litt.). As drying occurs, frogs become more concentrated in the remaining pools and thus, become more susceptible to competition (Moyle 1973, p. 21), predation (Storer 1925, p. 261; Moyle 1973, p. 21), and exposure to diseases and parasites (Kupferberg et al. 2009a, p. 529; Adams et al. 2017a, p. 11). Reduced flow volume is associated with increased Bd load in foothill yellow-legged frog habitat (Adams et al. 2017a, pp. 8, 11). Absence of strong winter flows enables bullfrogs to expand their spatial distributions, which also contributes to disease transmission (Adams et al. 2017a, pp. 1–2). Multi-year droughts can also lead to tree mortality, which in turn, increases wildfire risk.

Stressor: Wildfire
Exposure:
Response:
Consequence:
Narrative: The effects of wildfire on foothill yellow-legged frogs are not well understood and have not been directly studied (CDFW 2019b, p. 71). Anecdotally, foothill yellow-legged frog populations have shown signs of resiliency after low- to moderate-severity wildfires (Lind et al. 2003, p. 27; CDFW 2019b, p. 71). It is suspected that low-severity fires do not have any adverse effects on the foothill yellow-legged frog (Olson and Davis 2009, p. 24). In fact, wildfires may be beneficial to habitat quality by decreasing canopy cover and increasing habitat heterogeneity (Pilliod et al. 2003, pp. 171, 173; Olson and Davis 2009, p. 24). Direct mortality from scorching is unlikely given the species' aquatic nature and the sightings of foothill yellow-legged frogs immediately after wildfires.

Stressor: Extreme Flood Events
Exposure:
Response:
Consequence:
Narrative: Strong winter flows from heavy precipitation are typical in Mediterranean climates and small floods can maintain and improve foothill yellow-legged frog breeding habitat (Lind et al. 1996, pp. 64–65; Lind et al. 2016, p. 269; Power et al. 2016, p. 719). However, extreme flood events that only occur every few decades have the potential to cause severe habitat destruction and extirpations (Figure 43), especially when combined with other threats.

Stressor: Predators and Competition
Exposure:
Response:
Consequence:

Narrative: A variety of native and nonnative species prey upon foothill yellow-legged frogs. Predators include amphibians, birds, crustaceans, fish, aquatic insects, mammals, and reptiles (CDFW 2019b, p. 23, table 1). During the juvenile and adult life stages, garter snakes (Thamnophis spp.) probably account for most of the predation of foothill yellow-legged frogs (Zweifel 1955, p. 225; GANDA 2008, p. 36) (Figure 44). Although nonnative predation (especially by bullfrogs, crayfish, and fish) is given more attention than native predation (Hayes et al. 2016, pp. 56–57), native predation is also a serious concern, particularly when tadpoles and frogs are concentrated in shrinking, disconnected pools.

Recovery

Conservation Measures and Best Management Practices:

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Additional Threshold Information:

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References

USFWS. 2023. Species Status Assessment Report for the Foothill Yellow-legged Frog (Rana boylii). , Version 2.11. April 2023. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California.

SPECIES ACCOUNT: *Rana boylii* (Foothill yellow-legged frog)

Species Taxonomic and Listing Information

Listing Status: Endangered

Physical Description

the foothill yellow-legged frog is a small- to mediumsized (37 to 82 millimeters (mm) (1.5 to 3.2 inches (in.)) snout-urostyle length (SUL)) frog with indistinct dorsolateral folds, fully webbed feet, and rough pebbly skin. Dorsal color is highly variable and is usually light and dark mottled gray, olive, or brown, with variable amounts of brick red. The undersurfaces of the posterior abdomen and ventral surfaces of the rear legs are varying shades of yellow. The foothill yellow-legged frog is sexually dimorphic with females attaining larger sizes than males, and mature males having a dark swollen bump on the dorsomedial surface of each thumb, proportionally larger forearm muscles, and narrower waists. Juvenile foothill yellow-legged frogs are similar to adults except for their smaller size (14 to 36 mm (0.5 to 1.4 in.) SUL) more contrasting dorsal coloration, and lack of significant yellow on their undersurfaces (reviewed in Hayes et al. 2016, p. 4). Tadpoles can be distinguished from tadpoles of co-occurring species by the greater number (five or more) of rows of teeth in the upper and lower jaw (USFWS, 2023).

Taxonomy

The foothill yellow-legged frog retains its classification as Rana boylii, ascribed in 1854 by S.F. Baird (Baird 1854, p. 62; Frost 2019, not paginated). In 1955, the R. boylii (formerly spelled “boylei”) group was comprised of six Rana boylii subtaxa but were then split into six discrete taxa by Zweifel (1955, pp. 210, 273). The foothill yellow-legged frog is now the only entity classified as Rana boylii and the taxon is not subdivided into subtaxa (Zweifel 1968, pp. 71.1–71.2). However, this taxon continues to be the focus of genetic research, which has recently demonstrated that the foothill yellow-legged frog has deeper population structure than that observed in any anuran with similar data (McCartney-Melstad et al. 2018, p. 112). The California Department of Fish and Wildlife (CDFW) recently classified this species as having six unique, genetic clades (i.e., lineages) (USFWS, 2023)

Current Range

Sierra Nevada Mountains south of the American River sub-basin south to the Transverse Range in Kern County)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food Source

Juvenile: Juvenile and adult foothill yellowlegged frogs prey upon many types of aquatic and terrestrial invertebrates including snails, moths, flies, water striders, beetles, grasshoppers, hornets, and ants (USFWS, 2023).

Adult: Ranid species do not typically have specific food preferences in the adult life stage and feed upon a wide range of arthropods, small fish, and small frogs (Zweifel 1955, p. 223). Cannibalism has also been observed in the foothill yellow-legged frog under laboratory conditions (Zweifel 1955, p. 223). Juvenile and adult foothill yellowlegged frogs prey upon many types of aquatic and terrestrial invertebrates including snails, moths, flies, water striders, beetles, grasshoppers, hornets, and ants The arthropods identified from stomach contents (in the North Sierra unit) were predominantly insects (88 percent), followed by arachnids (12 percent) (van Wagner 1996, p. 89). Similarly, the stomach contents were primarily terrestrial (88 percent), as opposed to aquatic (i.e., captured on or under water) (USFWS, 2023).

Reproductive Strategy

Adult: Oviparity

Lifespan

Adult: Max. age between 11-13 years (USFWS, 2023)

Breeding Season

Adult: Breeding takes place between late March and early July (USFWS, 2023)

Other Reproductive Information

Adult: During the breeding season, foothill yellow-legged frogs exhibit a lek-style mating system, where males congregate at breeding sites and often establish small calling territories to attract female mates (Wheeler and Welsh 2008, pp. 137–138). Several types of vocalizations are made by male foothill yellow-legged frogs, primarily underwater (MacTague and Northen 1993, p. 1; Silver 2017, p. 33). The diversity of calls suggests that vocalizations are used for more than just mate attraction (MacTague and Northen 1993, p. 1). An underwater duet between a male and female foothill yellow-legged frog in amplexus (i.e., the mating position) has also been recorded (Silver 2017, p. 33). A study of vocalizations from foothill yellow-legged frog populations in three California counties (Mendocino, Butte, and Alameda counties) showed significant regional variation in dialect (USFWS, 2023).

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Adult: Moderate

Habitat Narrative

Adult: The foothill yellow-legged frog is a stream-obligate species that typically occurs from sea level to approximately 1,524 m (5,000 ft) (pers. comm. cited in CDFW 2019b, p. 8). The foothill yellow-legged frog occurs in a wide variety of vegetation types including valley-foothill hardwood, valley-foothill hardwood-conifer, valley-foothill riparian, ponderosa pine, mixed conifer, mixed chaparral, and wet meadow (Hayes et al. 2016, p. 5). The extensive range of the foothill yellow-legged frog demonstrates the species' non-specificity in regards to vegetation type and macroclimate of the species' terrestrial habitat component. Foothill yellow-legged frogs are primarily observed in or along the edges of streams (Zweifel 1955, p. 221; Kupferberg 1996a, p. 1339). Most foothill yellow-legged frogs breed along mainstem water channels and overwinter along smaller tributaries of the mainstem channel (Kupferberg 1996a, p. 1339; GANDA 2008, p. 20). Stream morphology is a strong predictor of breeding habitat because it creates the microhabitat conditions required for successful oviposition (i.e., egg-laying), hatching, growth, and metamorphosis. Foothill yellow-legged frogs that overwinter along tributaries often congregate at the same breeding locations along the mainstem each year (Kupferberg 1996a, p. 1334; Wheeler and Welsh 2008, p. 128). During the non-breeding season, the smaller tributaries, some of which may only flow during the wet winter season, provide refuge while the larger breeding channels may experience overbank flooding and high flows (Kupferberg 1996a, p. 1339). Habitat elements that provide both refuge from winter peak flows and adequate moisture for foothill yellow-legged frogs include pools, springs, seeps, submerged root wads, undercut banks, and large boulders or debris at high-water lines (USFWS, 2023). Foothill yellow-legged frogs appear to use different overwintering strategies in terms of seasonal movement and habitat type, even within a single population (Bourque 2008, p. 65). Generally, foothill yellow-legged frogs travel up along small tributaries where they become inactive for a period during the winter. However, foothill yellow-legged frogs may remain active during the winter if conditions are favorable (van Wagner 1996, pp. xix, 74). The foothill yellow-legged frog inactive period is variable among years and by geography, climate, and life stage. The inactive period, if it occurs at all, typically extends from mid-fall until late February or early March, with adults remaining inactive for longer periods than juveniles (Zweifel 1955, p. 226). Activity may begin earlier during mild winters and active individuals have been observed throughout the winter in the San Francisco Bay area (Zweifel 1955, p. 226). Compared to higher elevation populations, coastal populations and those in lower-elevations of the Sierra Nevada might be active for an extra month in the fall and extra month in the late winter; in the highest range elevations, the inactive period may be four or five months long (USFWS, 2023).

Dispersal/Migration

Dispersal

Adult: juvenile frogs were found dispersing into a residential neighborhood 16 to 331 m (52 to 1,086 ft) from the creek (USFWS, 2023)

Dispersal/Migration Narrative

Adult: In Mendocino County (North Coast California unit), juvenile frogs were found dispersing into a residential neighborhood 16 to 331 m (52 to 1,086 ft) from the creek (Cook et al. 2012, p. 325). In Tehama County (North Coast California unit), a radio-telemetered female traveled approximately 7 km (4.3 mi), using intermittent tributaries (some of which were dry with only moist substrates) and cresting a ridge (Bourque 2008, p. 30). Bourque (2008, p. 72) noted that adults at the Tehama County study site typically moved during hot and dry conditions but avoided desiccation by restricting travel routes to drainage networks with moist substrates (USFWS, 2023).

Population Information and Trends

Population Trends:

Declining (USFWS, 2023)

Number of Populations:

4 listed populations

Population Narrative:

Subpopulations are subject to periodic extirpation from demographic or environmental stochasticity, but then are naturally repopulated via colonization from nearby subpopulations. Therefore, it is more informative to look at species' status at the metapopulation level, which is more stable than the subpopulation level. A metapopulation is distinguished from an adjacent metapopulation by the rate of gene flow, with gene flow and recolonization rates being greater within a single metapopulation than between adjacent metapopulations. Given this definition, we can deduce that each of the six foothill yellow-legged frog genetic clades (2.6 Genetic Clades) contains one or more metapopulations that are unique to that clade. Often, metapopulations are separated by large distances (greater than typical dispersal distances) and/or unsuitable habitat, or by topological features that act as barriers to dispersal. Although there is information about distances moved by marked frogs (up to 1000's of m (Bourque 2008, p. 30; Gonsolin 2010, p. 38)) and the distances at which genetic differentiation can be observed (10 km (6.2 mi) (Dever 2007, p. 171;)), the actual boundaries of foothill yellow-legged frog metapopulations are largely unknown. Population models demonstrate how foothill yellow-legged frog population abundance can have a sizeable effect on extirpation probability (Kupferberg et al. 2009c, p. ix; Rose et al. 2021, p. 12, figure 5). However, the minimum abundance required for a foothill yellow-legged frog population to be viable (i.e., minimum viable population) over an extended period is unknown. Multi-year survey data show how the average abundance of breeding females per km varies drastically among populations (Rose et al. 2020, pp. 63–64, table 1). The highest abundances (>100 breeding females per km) have only been recorded in the North Coast California unit (Rose et al. 2020, pp. 63–64, 76, table 1, figure 4). One of the most abundant foothill yellowlegged frog populations is along the Mad River (Humboldt County, North Coast California unit) where the average breeding female density was 259 per km for 2008–2019 (Green Diamond Resource Company 2020, in litt.). Egg mass abundance (i.e., proxy for number of breeding females) peaked in 2017 when 1,469 egg masses were counted within a 2.35 km stretch of the Mad River during a single survey (Green Diamond Resource Company 2020, in litt.). There are also populations that have exhibited long-term stability with much lower abundances, such as 18 breeding females per km, in some Central Coast unit streams (Rose et al. 2020, pp. 63, 76, table 1, figure 4). Locations where breeding female abundances are much lower (e.g., 5 per km) could be population sinks where female emigrants from nearby populations lay eggs but recruitment typically fails due to poor spawning and rearing conditions (USFWS, 2023).

Threats and Stressors

Stressor: Altered hydrology
Exposure:
Response:
Consequence:
Narrative: Dams and other waterway modifications alter the hydrology, temperature, and morphology of foothill yellow-legged frog stream habitat.

Stressor: Nonnative species
Exposure:
Response:
Consequence:
Narrative: Foothill yellow-legged frog viability can be negatively influenced by several nonnative animal species. The American bullfrog (Lithobates catesbeianus, also known as Rana catesbeiana), nonnative crayfish (Pacifastacus spp.), and nonnative fish (e.g., smallmouth bass (Micropterus dolomieu)) have all been linked to decreases in foothill yellow-legged frogs (Olson and Davis 2009, pp. 17–18; Hayes et al. 2016, pp. 49–51). The following subsections provide details on how these nonnative species influence the foothill yellow-legged frog at various life stages by increasing predation, competition, and/or disease transmission. Other nonnative species, such as the barred owl (Strix varia), might also negatively influence foothill yellow-legged frog viability but are not discussed in detail because of limited information. Barred owls are suspected to be an emerging threat to foothill yellow-legged frogs in the North Coast analysis units (D. Olson 2021, in litt.) because of their predation of ranid frogs.

Stressor: Disease and parasites
Exposure:
Response:
Consequence:
Narrative: Foothill yellow-legged frog viability can be negatively influenced by the presence of Batrachochytrium dendrobatidis (Bd; causative agent of chytridiomycosis), parasitic copepods, and water molds (Saprolegniaceae family).

Stressor: Sedimentation
Exposure:
Response:
Consequence:

Narrative: Sedimentation is a threat for foothill yellow-legged frogs because it reduces the availability of important habitat features including coarse rocky substrates, geomorphic heterogeneity, and interstitial spaces. Increased sedimentation can increase turbidity, impact food resources, or impede foothill yellow-legged frog egg mass attachment to substrate (Cordone and Kelley 1961, pp. 191–192; Ashton et al. 1997, p. 13). Fine sediments can also fill interstitial spaces between rocks, which provide shelter from high velocity flows, cover from predators, and sources of aquatic invertebrate prey.

Stressor: Agriculture
Exposure:
Response:
Consequence:
Narrative: Agriculture is a source of threats to the foothill yellow-legged frog because of agriculture's role in habitat degradation, contribution of pesticides and pollutants to the environment, and role as a driver of other threats such as altered hydrology and nonnative species (Figure 26). Agricultural land uses have been linked to declines in foothill yellow-legged frog populations (Davidson et al. 2002, p. 1597; Lind 2005, pp. 19, 51, 62, table 2.2). Foothill yellow-legged frog presence is negatively associated with agriculture within 5 km (3.1 mi).

Stressor: Mining
Exposure:
Response:
Consequence:
Narrative: Mining is a source of threats to the foothill yellow-legged frog because of its role in habitat destruction and degradation, pollution, and expansion of nonnative species (Figure 29). Several types of mining practices have negatively affected foothill yellow-legged frog habitat; these include aggregate, hard-rock, hydraulic, and suction-dredge mining.

Stressor: Urbanization, Roads, and Recreation
Exposure:
Response:
Consequence:
Narrative: Urbanization, roads, and recreation can affect foothill yellow-legged frog viability directly through mortality, but they are also major sources of threats to the foothill yellow-legged frog because of their role in habitat destruction, degradation, and fragmentation; contribution of pesticides and pollutants to the environment; and their role as drivers of other threats such as altered hydrology, nonnative species, and disease transmission (Figure 30). Conversion or alteration of natural habitats for urban land uses has been linked to declines in foothill yellowlegged frog populations (Davidson et al. 2002, p. 1597; Lind 2005, pp. 19, 51, 62, table 2.2). Foothill yellow-legged frog presence is negatively associated with cities and road density (Davidson et al. 2002, p. 1594; Olson and Davis 2009, p. 22). Increases in urbanization and roads have been reportedly associated with foothill yellow-legged frog extirpations in the South Coast unit, possibly by facilitating the spread of Bd and nonnative species.

Stressor: Drying and Drought
Exposure:
Response:
Consequence:

Narrative: Temporary drying of waterways (from anthropogenic water allocation and/or drought) is implicated in declines and extirpations of foothill yellow-legged frogs because it shortens the hydroperiod; negatively affects habitat elements that are hydrology-dependent; limits recruitment, survival, and connectivity; and exacerbates the effects of other threats (Figure 33, Figure 34). Periodic drying of waterways and/or drought occurs naturally in foothill yellowlegged frog habitat, particularly in the southern analysis units (South Sierra, Central Coast, and South Coast units) (Adams et al. 2017b, p. 10227), but frequency of drying and drought is increasing because of anthropogenic water use and the effects of climate change (Section 7.13). Breeding sites that completely dried during consecutive severe drought years had zero reproductive success (S. Kupferberg, pers. comm. cited in Wheeler et al. 2018, p. 296; M. Parker 2021, in litt.). As drying occurs, frogs become more concentrated in the remaining pools and thus, become more susceptible to competition (Moyle 1973, p. 21), predation (Storer 1925, p. 261; Moyle 1973, p. 21), and exposure to diseases and parasites (Kupferberg et al. 2009a, p. 529; Adams et al. 2017a, p. 11). Reduced flow volume is associated with increased Bd load in foothill yellow-legged frog habitat (Adams et al. 2017a, pp. 8, 11). Absence of strong winter flows enables bullfrogs to expand their spatial distributions, which also contributes to disease transmission (Adams et al. 2017a, pp. 1–2). Multi-year droughts can also lead to tree mortality, which in turn, increases wildfire risk.

Stressor: Wildfire
Exposure:
Response:
Consequence:
Narrative: The effects of wildfire on foothill yellow-legged frogs are not well understood and have not been directly studied (CDFW 2019b, p. 71). Anecdotally, foothill yellow-legged frog populations have shown signs of resiliency after low- to moderate-severity wildfires (Lind et al. 2003, p. 27; CDFW 2019b, p. 71). It is suspected that low-severity fires do not have any adverse effects on the foothill yellow-legged frog (Olson and Davis 2009, p. 24). In fact, wildfires may be beneficial to habitat quality by decreasing canopy cover and increasing habitat heterogeneity (Pilliod et al. 2003, pp. 171, 173; Olson and Davis 2009, p. 24). Direct mortality from scorching is unlikely given the species' aquatic nature and the sightings of foothill yellow-legged frogs immediately after wildfires.

Stressor: Extreme Flood Events
Exposure:
Response:
Consequence:
Narrative: Strong winter flows from heavy precipitation are typical in Mediterranean climates and small floods can maintain and improve foothill yellow-legged frog breeding habitat (Lind et al. 1996, pp. 64–65; Lind et al. 2016, p. 269; Power et al. 2016, p. 719). However, extreme flood events that only occur every few decades have the potential to cause severe habitat destruction and extirpations (Figure 43), especially when combined with other threats.

Stressor: Predators and Competition
Exposure:
Response:
Consequence:

Narrative: A variety of native and nonnative species prey upon foothill yellow-legged frogs. Predators include amphibians, birds, crustaceans, fish, aquatic insects, mammals, and reptiles (CDFW 2019b, p. 23, table 1). During the juvenile and adult life stages, garter snakes (Thamnophis spp.) probably account for most of the predation of foothill yellow-legged frogs (Zweifel 1955, p. 225; GANDA 2008, p. 36) (Figure 44). Although nonnative predation (especially by bullfrogs, crayfish, and fish) is given more attention than native predation (Hayes et al. 2016, pp. 56–57), native predation is also a serious concern, particularly when tadpoles and frogs are concentrated in shrinking, disconnected pools.

Recovery

Conservation Measures and Best Management Practices:

-

Additional Threshold Information:

-
-

References

USFWS. 2023. Species Status Assessment Report for the Foothill Yellow-legged Frog (Rana boylii). , Version 2.11. April 2023. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California.

SPECIES ACCOUNT: *Rana boylii* (Foothill yellow-legged frog)

Species Taxonomic and Listing Information

Listing Status: Threatened

Physical Description

the foothill yellow-legged frog is a small- to mediumsized (37 to 82 millimeters (mm) (1.5 to 3.2 inches (in.)) snout-urostyle length (SUL)) frog with indistinct dorsolateral folds, fully webbed feet, and rough pebbly skin. Dorsal color is highly variable and is usually light and dark mottled gray, olive, or brown, with variable amounts of brick red. The undersurfaces of the posterior abdomen and ventral surfaces of the rear legs are varying shades of yellow. The foothill yellow-legged frog is sexually dimorphic with females attaining larger sizes than males, and mature males having a dark swollen bump on the dorsomedial surface of each thumb, proportionally larger forearm muscles, and narrower waists. Juvenile foothill yellow-legged frogs are similar to adults except for their smaller size (14 to 36 mm (0.5 to 1.4 in.) SUL) more contrasting dorsal coloration, and lack of significant yellow on their undersurfaces (reviewed in Hayes et al. 2016, p. 4). Tadpoles can be distinguished from tadpoles of co-occurring species by the greater number (five or more) of rows of teeth in the upper and lower jaw (USFWS, 2023).

Taxonomy

The foothill yellow-legged frog retains its classification as Rana boylii, ascribed in 1854 by S.F. Baird (Baird 1854, p. 62; Frost 2019, not paginated). In 1955, the R. boylii (formerly spelled “boylei”) group was comprised of six Rana boylii subtaxa but were then split into six discrete taxa by Zweifel (1955, pp. 210, 273). The foothill yellow-legged frog is now the only entity classified as Rana boylii and the taxon is not subdivided into subtaxa (Zweifel 1968, pp. 71.1–71.2). However, this taxon continues to be the focus of genetic research, which has recently demonstrated that the foothill yellow-legged frog has deeper population structure than that observed in any anuran with similar data (McCartney-Melstad et al. 2018, p. 112). The California Department of Fish and Wildlife (CDFW) recently classified this species as having six unique, genetic clades (i.e., lineages) (USFWS, 2023)

Current Range

North Feather River watershed largely in Plumas and Butte Counties)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food Source

<u>Larvae:</u> algae (USFWS, 2023)

<u>Juvenile:</u> Juvenile and adult foothill yellowlegged frogs prey upon many types of aquatic and terrestrial invertebrates including snails, moths, flies, water striders, beetles, grasshoppers, hornets, and ants (USFWS, 2023).

Adult: Ranid species do not typically have specific food preferences in the adult life stage and feed upon a wide range of arthropods, small fish, and small frogs (Zweifel 1955, p. 223). Cannibalism has also been observed in the foothill yellow-legged frog under laboratory conditions (Zweifel 1955, p. 223). Juvenile and adult foothill yellowlegged frogs prey upon many types of aquatic and terrestrial invertebrates including snails, moths, flies, water striders, beetles, grasshoppers, hornets, and ants The arthropods identified from stomach contents (in the North Sierra unit) were predominantly insects (88 percent), followed by arachnids (12 percent) (van Wagner 1996, p. 89). Similarly, the stomach contents were primarily terrestrial (88 percent), as opposed to aquatic (i.e., captured on or under water) (USFWS, 2023).

Reproductive Strategy

Adult: Oviparity

Lifespan

Adult: Max. age between 11-13 years (USFWS, 2023)

Breeding Season

Adult: Breeding takes place between late March and early July (USFWS, 2023)

Other Reproductive Information

Adult: During the breeding season, foothill yellow-legged frogs exhibit a lek-style mating system, where males congregate at breeding sites and often establish small calling territories to attract female mates (Wheeler and Welsh 2008, pp. 137–138). Several types of vocalizations are made by male foothill yellow-legged frogs, primarily underwater (MacTague and Northen 1993, p. 1; Silver 2017, p. 33). The diversity of calls suggests that vocalizations are used for more than just mate attraction (MacTague and Northen 1993, p. 1). An underwater duet between a male and female foothill yellow-legged frog in amplexus (i.e., the mating position) has also been recorded (Silver 2017, p. 33). A study of vocalizations from foothill yellow-legged frog populations in three California counties (Mendocino, Butte, and Alameda counties) showed significant regional variation in dialect (USFWS, 2023).

Reproduction Narrative

Egg: Egg masses require a narrow range of microsite conditions for successful hatching (Kupferberg 1996a, p. 1336; Lind et al. 2016, p. 263). Embryonic development is highly temperature dependent (Hayes et al. 2016, p. 14). Hatching may take anywhere from approximately 5 days at 20 °C (68 °F) (Zweifel 1955, p. 229) to 36 days (pers. obs. cited in Hayes et al. 2016, p. 15). Oviposition microsites have shallow water depths and slow water velocities when compared to ambient conditions (Kupferberg 1996a, p. 1336; Wheeler et al. 2006, p. 7; Bondi et al. 2013, p. 93). Substrate (i.e., streambed surface material) also plays a critical role in oviposition site selection, with most egg masses being attached to cobblestones and/or the downstream side of rocks (Storer 1925, p. 253; Kupferberg 1996a, p. 1336). Under ideal conditions, hatching success is approximately 83 percent and does not appear to vary across the species' range (USFWS, 2023).

Larvae: The tadpole (larval) stage (Figure 7), from hatching to metamorphosis (Gosner stages approximately 21 to 41 (Gosner 1960, entire)), may last from approximately 7 weeks (Wheeler et al. 2015, p. 1280) to four months (Storer 1925, p. 255; Catenazzi and Kupferberg 2013, p. 46).

Time from hatching to metamorphosis varies; tadpoles reach metamorphosis more quickly as temperature and algal food availability increase (Kupferberg et al. 2011a, entire; Catenazzi and Kupferberg 2013, p. 46). Unless disturbed, newly hatched tadpoles remain with the egg mass for several days (Ashton et al. 1997, pp. 7, 9) (Figure 8). After this, young tadpoles disperse short distances and begin using interstitial spaces in the stream substrate for shelter (Ashton et al. 1997, p. 9). Under sub-optimal conditions, tadpoles remain in this vulnerable life stage for longer, which increases risk of mortality. Furthermore, tadpoles may fail to undergo, or complete metamorphosis prior to fall/winter flows, which can cause mortality because foothill yellowlegged frogs do not have morphological adaptations that would allow them to withstand high water-velocity conditions (Kupferberg et al. 2009c, p. 6). In temperature-controlled laboratory experiments, tadpoles from Sierra Nevadan populations demonstrated a capacity for faster growth and development than tadpoles from coastal populations (USFWS, 2023).

Juvenile: Juvenile foothill yellow-legged frogs (Figure 10) are post-metamorphic frogs that have not yet developed sexual reproductive characteristics. Juveniles are typically less than 40 mm (1.6 in.) SUL, with females maturing at a larger size than males (Kupferberg et al. 2009c, p. 34). Juveniles can remain active and grow during the winter (Rombough 2006b, p. 159), but grow very little (Storer 1925, pp. 255–256). During the breeding season following metamorphosis, wild juvenile frogs (i.e., yearlings) are still smaller than adults and do not breed (Storer 1925, p. 256; Zweifel 1955, p. 229). In most populations, female foothill yellow-legged frogs begin reproductive activity during their third spring post-metamorphosis; however, evidence suggests that in some central coast populations, females breed during their second spring (USFWS, 2023).

Adult: Throughout the range of the species, breeding takes place between late March and early July (Zweifel 1955, p. 228; Yarnell et al. 2013, pp. 64, 67, table 14), during the transition from wet season to dry season. Onset and duration of the foothill yellow-legged frog breeding season is plastic and closely linked to the natural hydrologic cycle (Wheeler and Welsh 2008, p. 128) and water temperature (Kupferberg 1996a, p. 1337; Wheeler et al. 2018, p. 294). Male frogs begin breeding vocalizations when water levels and flow rates decrease following rain and snowmelt runoff events (Wheeler et al. 2018, p. 293). In general, the initiation of breeding occurs during a gradual decrease in stream flow rate while water temperatures rise above 10 degrees Celsius (°C) (50 degrees Fahrenheit (°F)). Initiation of breeding activity and oviposition (i.e., egg-laying) is extremely variable among years and by geography (Wheeler et al. 2018, pp. 289, 292–293). Breeding may occur earlier during low base-flow years and later during high base-flow years (Kupferberg 1996a, p. 1337 (Eel River); Wheeler and Welsh 2008, p. 136 (Hurdygurdy Creek); Yarnell et al. 2013, p. 66, figure 41 (North Fork American)). However, studies in some locations suggest that initiation of breeding activity is more closely linked to photoperiod (i.e., day of the year) than to interannual variations in streamflow (Gonsolin 2010, p. 49). Temporary cessation of breeding activity has been observed when rain events increase stream flow (Wheeler and Welsh 2008, p. 136; Gonsolin 2010, p. 51). This may occur because higher flows submerge male calling sites and underwater velocities would be too high for oviposition (Wheeler and Welsh 2008, p. 136). In Oregon, larger populations (i.e., those with more than 100 breeding adults) consistently had longer periods of breeding activity than smaller populations and researchers potentially attributed the longer breeding season duration to the influence of population abundance (USFWS, 2023).

Habitat Type

Adult: wide variety of vegetation types including valley-foothill hardwood, valley-foothill hardwood-conifer, valley-foothill riparian, ponderosa pine, mixed conifer, mixed chaparral, and wet meadow (USFWS, 2023).

Environmental Specificity

Adult: Narrow

Tolerance Ranges/Thresholds

Adult: Moderate

Site Fidelity

Adult: Moderate

Habitat Narrative

Adult: The foothill yellow-legged frog is a stream-obligate species that typically occurs from sea level to approximately 1,524 m (5,000 ft) (pers. comm. cited in CDFW 2019b, p. 8). The foothill yellow-legged frog occurs in a wide variety of vegetation types including valley-foothill hardwood, valley-foothill hardwood-conifer, valley-foothill riparian, ponderosa pine, mixed conifer, mixed chaparral, and wet meadow (Hayes et al. 2016, p. 5). The extensive range of the foothill yellow-legged frog demonstrates the species' non-specificity in regards to vegetation type and macroclimate of the species' terrestrial habitat component. Foothill yellow-legged frogs are primarily observed in or along the edges of streams (Zweifel 1955, p. 221; Kupferberg 1996a, p. 1339). Most foothill yellow-legged frogs breed along mainstem water channels and overwinter along smaller tributaries of the mainstem channel (Kupferberg 1996a, p. 1339; GANDA 2008, p. 20). Stream morphology is a strong predictor of breeding habitat because it creates the microhabitat conditions required for successful oviposition (i.e., egg-laying), hatching, growth, and metamorphosis. Foothill yellow-legged frogs that overwinter along tributaries often congregate at the same breeding locations along the mainstem each year (Kupferberg 1996a, p. 1334; Wheeler and Welsh 2008, p. 128). During the non-breeding season, the smaller tributaries, some of which may only flow during the wet winter season, provide refuge while the larger breeding channels may experience overbank flooding and high flows (Kupferberg 1996a, p. 1339). Habitat elements that provide both refuge from winter peak flows and adequate moisture for foothill yellow-legged frogs include pools, springs, seeps, submerged root wads, undercut banks, and large boulders or debris at high-water lines (USFWS, 2023). Foothill yellow-legged frogs appear to use different overwintering strategies in terms of seasonal movement and habitat type, even within a single population (Bourque 2008, p. 65). Generally, foothill yellow-legged frogs travel up along small tributaries where they become inactive for a period during the winter. However, foothill yellow-legged frogs may remain active during the winter if conditions are favorable (van Wagner 1996, pp. xix, 74). The foothill yellow-legged frog inactive period is variable among years and by geography, climate, and life stage. The inactive period, if it occurs at all, typically extends from mid-fall until late February or early March, with adults remaining inactive for longer periods than juveniles (Zweifel 1955, p. 226). Activity may begin earlier during mild winters and active individuals have been observed throughout the winter in the San Francisco Bay area (Zweifel 1955, p. 226). Compared to higher elevation populations, coastal populations and those in lower-elevations of the Sierra Nevada might be active for an extra month in the fall and extra month in the late winter; in the highest range elevations, the inactive period may be four or five months long (USFWS, 2023).

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Population Trends:

Declining (USFWS, 2023)

Number of Populations:

4 listed populations

Population Narrative:

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Threats and Stressors

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Exposure:
Response:
Consequence:
Narrative: Dams and other waterway modifications alter the hydrology, temperature, and morphology of foothill yellow-legged frog stream habitat.

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Exposure:
Response:
Consequence:
Narrative: Foothill yellow-legged frog viability can be negatively influenced by several nonnative animal species. The American bullfrog (Lithobates catesbeianus, also known as Rana catesbeiana), nonnative crayfish (Pacifastacus spp.), and nonnative fish (e.g., smallmouth bass (Micropterus dolomieu)) have all been linked to decreases in foothill yellow-legged frogs (Olson and Davis 2009, pp. 17–18; Hayes et al. 2016, pp. 49–51). The following subsections provide details on how these nonnative species influence the foothill yellow-legged frog at various life stages by increasing predation, competition, and/or disease transmission. Other nonnative species, such as the barred owl (Strix varia), might also negatively influence foothill yellow-legged frog viability but are not discussed in detail because of limited information. Barred owls are suspected to be an emerging threat to foothill yellow-legged frogs in the North Coast analysis units (D. Olson 2021, in litt.) because of their predation of ranid frogs.

Stressor: Disease and parasites
Exposure:
Response:
Consequence:
Narrative: Foothill yellow-legged frog viability can be negatively influenced by the presence of Batrachochytrium dendrobatidis (Bd; causative agent of chytridiomycosis), parasitic copepods, and water molds (Saprolegniaceae family).

Stressor: Sedimentation
Exposure:
Response:
Consequence:

Narrative: Sedimentation is a threat for foothill yellow-legged frogs because it reduces the availability of important habitat features including coarse rocky substrates, geomorphic heterogeneity, and interstitial spaces. Increased sedimentation can increase turbidity, impact food resources, or impede foothill yellow-legged frog egg mass attachment to substrate (Cordone and Kelley 1961, pp. 191–192; Ashton et al. 1997, p. 13). Fine sediments can also fill interstitial spaces between rocks, which provide shelter from high velocity flows, cover from predators, and sources of aquatic invertebrate prey.

Stressor: Agriculture
Exposure:
Response:
Consequence:
Narrative: Agriculture is a source of threats to the foothill yellow-legged frog because of agriculture's role in habitat degradation, contribution of pesticides and pollutants to the environment, and role as a driver of other threats such as altered hydrology and nonnative species (Figure 26). Agricultural land uses have been linked to declines in foothill yellow-legged frog populations (Davidson et al. 2002, p. 1597; Lind 2005, pp. 19, 51, 62, table 2.2). Foothill yellow-legged frog presence is negatively associated with agriculture within 5 km (3.1 mi).

Stressor: Mining
Exposure:
Response:
Consequence:
Narrative: Mining is a source of threats to the foothill yellow-legged frog because of its role in habitat destruction and degradation, pollution, and expansion of nonnative species (Figure 29). Several types of mining practices have negatively affected foothill yellow-legged frog habitat; these include aggregate, hard-rock, hydraulic, and suction-dredge mining.

Stressor: Urbanization, Roads, and Recreation
Exposure:
Response:
Consequence:
Narrative: Urbanization, roads, and recreation can affect foothill yellow-legged frog viability directly through mortality, but they are also major sources of threats to the foothill yellow-legged frog because of their role in habitat destruction, degradation, and fragmentation; contribution of pesticides and pollutants to the environment; and their role as drivers of other threats such as altered hydrology, nonnative species, and disease transmission (Figure 30). Conversion or alteration of natural habitats for urban land uses has been linked to declines in foothill yellowlegged frog populations (Davidson et al. 2002, p. 1597; Lind 2005, pp. 19, 51, 62, table 2.2). Foothill yellow-legged frog presence is negatively associated with cities and road density (Davidson et al. 2002, p. 1594; Olson and Davis 2009, p. 22). Increases in urbanization and roads have been reportedly associated with foothill yellow-legged frog extirpations in the South Coast unit, possibly by facilitating the spread of Bd and nonnative species.

Stressor: Drying and Drought
Exposure:
Response:
Consequence:

Narrative: Temporary drying of waterways (from anthropogenic water allocation and/or drought) is implicated in declines and extirpations of foothill yellow-legged frogs because it shortens the hydroperiod; negatively affects habitat elements that are hydrology-dependent; limits recruitment, survival, and connectivity; and exacerbates the effects of other threats (Figure 33, Figure 34). Periodic drying of waterways and/or drought occurs naturally in foothill yellowlegged frog habitat, particularly in the southern analysis units (South Sierra, Central Coast, and South Coast units) (Adams et al. 2017b, p. 10227), but frequency of drying and drought is increasing because of anthropogenic water use and the effects of climate change (Section 7.13). Breeding sites that completely dried during consecutive severe drought years had zero reproductive success (S. Kupferberg, pers. comm. cited in Wheeler et al. 2018, p. 296; M. Parker 2021, in litt.). As drying occurs, frogs become more concentrated in the remaining pools and thus, become more susceptible to competition (Moyle 1973, p. 21), predation (Storer 1925, p. 261; Moyle 1973, p. 21), and exposure to diseases and parasites (Kupferberg et al. 2009a, p. 529; Adams et al. 2017a, p. 11). Reduced flow volume is associated with increased Bd load in foothill yellow-legged frog habitat (Adams et al. 2017a, pp. 8, 11). Absence of strong winter flows enables bullfrogs to expand their spatial distributions, which also contributes to disease transmission (Adams et al. 2017a, pp. 1–2). Multi-year droughts can also lead to tree mortality, which in turn, increases wildfire risk.

Stressor: Wildfire
Exposure:
Response:
Consequence:
Narrative: The effects of wildfire on foothill yellow-legged frogs are not well understood and have not been directly studied (CDFW 2019b, p. 71). Anecdotally, foothill yellow-legged frog populations have shown signs of resiliency after low- to moderate-severity wildfires (Lind et al. 2003, p. 27; CDFW 2019b, p. 71). It is suspected that low-severity fires do not have any adverse effects on the foothill yellow-legged frog (Olson and Davis 2009, p. 24). In fact, wildfires may be beneficial to habitat quality by decreasing canopy cover and increasing habitat heterogeneity (Pilliod et al. 2003, pp. 171, 173; Olson and Davis 2009, p. 24). Direct mortality from scorching is unlikely given the species' aquatic nature and the sightings of foothill yellow-legged frogs immediately after wildfires.

Stressor: Extreme Flood Events
Exposure:
Response:
Consequence:
Narrative: Strong winter flows from heavy precipitation are typical in Mediterranean climates and small floods can maintain and improve foothill yellow-legged frog breeding habitat (Lind et al. 1996, pp. 64–65; Lind et al. 2016, p. 269; Power et al. 2016, p. 719). However, extreme flood events that only occur every few decades have the potential to cause severe habitat destruction and extirpations (Figure 43), especially when combined with other threats.

Stressor: Predators and Competition
Exposure:
Response:
Consequence:

Narrative: A variety of native and nonnative species prey upon foothill yellow-legged frogs. Predators include amphibians, birds, crustaceans, fish, aquatic insects, mammals, and reptiles (CDFW 2019b, p. 23, table 1). During the juvenile and adult life stages, garter snakes (Thamnophis spp.) probably account for most of the predation of foothill yellow-legged frogs (Zweifel 1955, p. 225; GANDA 2008, p. 36) (Figure 44). Although nonnative predation (especially by bullfrogs, crayfish, and fish) is given more attention than native predation (Hayes et al. 2016, pp. 56–57), native predation is also a serious concern, particularly when tadpoles and frogs are concentrated in shrinking, disconnected pools.

Recovery

Conservation Measures and Best Management Practices:

-

Additional Threshold Information:

-
-

References

USFWS. 2023. Species Status Assessment Report for the Foothill Yellow-legged Frog (Rana boylii). , Version 2.11. April 2023. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California.

SPECIES ACCOUNT: *Rana boylii* (Foothill yellow-legged frog)

Species Taxonomic and Listing Information

Listing Status: Threatened

Physical Description

the foothill yellow-legged frog is a small- to mediumsized (37 to 82 millimeters (mm) (1.5 to 3.2 inches (in.)) snout-urostyle length (SUL)) frog with indistinct dorsolateral folds, fully webbed feet, and rough pebbly skin. Dorsal color is highly variable and is usually light and dark mottled gray, olive, or brown, with variable amounts of brick red. The undersurfaces of the posterior abdomen and ventral surfaces of the rear legs are varying shades of yellow. The foothill yellow-legged frog is sexually dimorphic with females attaining larger sizes than males, and mature males having a dark swollen bump on the dorsomedial surface of each thumb, proportionally larger forearm muscles, and narrower waists. Juvenile foothill yellow-legged frogs are similar to adults except for their smaller size (14 to 36 mm (0.5 to 1.4 in.) SUL) more contrasting dorsal coloration, and lack of significant yellow on their undersurfaces (reviewed in Hayes et al. 2016, p. 4). Tadpoles can be distinguished from tadpoles of co-occurring species by the greater number (five or more) of rows of teeth in the upper and lower jaw (USFWS, 2023).

Taxonomy

The foothill yellow-legged frog retains its classification as Rana boylii, ascribed in 1854 by S.F. Baird (Baird 1854, p. 62; Frost 2019, not paginated). In 1955, the R. boylii (formerly spelled "boylei") group was comprised of six Rana boylii subtaxa but were then split into six discrete taxa by Zweifel (1955, pp. 210, 273). The foothill yellow-legged frog is now the only entity classified as Rana boylii and the taxon is not subdivided into subtaxa (Zweifel 1968, pp. 71.1–71.2). However, this taxon continues to be the focus of genetic research, which has recently demonstrated that the foothill yellow-legged frog has deeper population structure than that observed in any anuran with similar data (McCartney-Melstad et al. 2018, p. 112). The California Department of Fish and Wildlife (CDFW) recently classified this species as having six unique, genetic clades (i.e., lineages) (USFWS, 2023)

Current Range

California, Central Coast Range south of San Francisco Bay to San Benito and Fresno Counties

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food Source

Larvae: algae (USFWS, 2023)

Juvenile: Juvenile and adult foothill yellowlegged frogs prey upon many types of aquatic and terrestrial invertebrates including snails, moths, flies, water striders, beetles, grasshoppers, hornets, and ants (USFWS, 2023).

Adult: Ranid species do not typically have specific food preferences in the adult life stage and feed upon a wide range of arthropods, small fish, and small frogs (Zweifel 1955, p. 223). Cannibalism has also been observed in the foothill yellow-legged frog under laboratory conditions (Zweifel 1955, p. 223). Juvenile and adult foothill yellowlegged frogs prey upon many types of aquatic and terrestrial invertebrates including snails, moths, flies, water striders, beetles, grasshoppers, hornets, and ants The arthropods identified from stomach contents (in the North Sierra unit) were predominantly insects (88 percent), followed by arachnids (12 percent) (van Wagner 1996, p. 89). Similarly, the stomach contents were primarily terrestrial (88 percent), as opposed to aquatic (i.e., captured on or under water) (USFWS, 2023).

Reproductive Strategy

Adult: Oviparity

Lifespan

Adult: Max. age between 11-13 years (USFWS, 2023)

Breeding Season

Adult: Breeding takes place between late March and early July (USFWS, 2023)

Other Reproductive Information

Adult: During the breeding season, foothill yellow-legged frogs exhibit a lek-style mating system, where males congregate at breeding sites and often establish small calling territories to attract female mates (Wheeler and Welsh 2008, pp. 137–138). Several types of vocalizations are made by male foothill yellow-legged frogs, primarily underwater (MacTague and Northen 1993, p. 1; Silver 2017, p. 33). The diversity of calls suggests that vocalizations are used for more than just mate attraction (MacTague and Northen 1993, p. 1). An underwater duet between a male and female foothill yellow-legged frog in amplexus (i.e., the mating position) has also been recorded (Silver 2017, p. 33). A study of vocalizations from foothill yellow-legged frog populations in three California counties (Mendocino, Butte, and Alameda counties) showed significant regional variation in dialect (USFWS, 2023).

Reproduction Narrative

Egg: Egg masses require a narrow range of microsite conditions for successful hatching (Kupferberg 1996a, p. 1336; Lind et al. 2016, p. 263). Embryonic development is highly temperature dependent (Hayes et al. 2016, p. 14). Hatching may take anywhere from approximately 5 days at 20 °C (68 °F) (Zweifel 1955, p. 229) to 36 days (pers. obs. cited in Hayes et al. 2016, p. 15). Oviposition microsites have shallow water depths and slow water velocities when compared to ambient conditions (Kupferberg 1996a, p. 1336; Wheeler et al. 2006, p. 7; Bondi et al. 2013, p. 93). Substrate (i.e., streambed surface material) also plays a critical role in oviposition site selection, with most egg masses being attached to cobblestones and/or the downstream side of rocks (Storer 1925, p. 253; Kupferberg 1996a, p. 1336). Under ideal conditions, hatching success is approximately 83 percent and does not appear to vary across the species' range (USFWS, 2023).

Larvae: The tadpole (larval) stage (Figure 7), from hatching to metamorphosis (Gosner stages approximately 21 to 41 (Gosner 1960, entire)), may last from approximately 7 weeks (Wheeler et al. 2015, p. 1280) to four months (Storer 1925, p. 255; Catenazzi and Kupferberg 2013, p. 46).

Time from hatching to metamorphosis varies; tadpoles reach metamorphosis more quickly as temperature and algal food availability increase (Kupferberg et al. 2011a, entire; Catenazzi and Kupferberg 2013, p. 46). Unless disturbed, newly hatched tadpoles remain with the egg mass for several days (Ashton et al. 1997, pp. 7, 9) (Figure 8). After this, young tadpoles disperse short distances and begin using interstitial spaces in the stream substrate for shelter (Ashton et al. 1997, p. 9). Under sub-optimal conditions, tadpoles remain in this vulnerable life stage for longer, which increases risk of mortality. Furthermore, tadpoles may fail to undergo, or complete metamorphosis prior to fall/winter flows, which can cause mortality because foothill yellowlegged frogs do not have morphological adaptations that would allow them to withstand high water-velocity conditions (Kupferberg et al. 2009c, p. 6). In temperature-controlled laboratory experiments, tadpoles from Sierra Nevadan populations demonstrated a capacity for faster growth and development than tadpoles from coastal populations (USFWS, 2023).

Juvenile: Juvenile foothill yellow-legged frogs (Figure 10) are post-metamorphic frogs that have not yet developed sexual reproductive characteristics. Juveniles are typically less than 40 mm (1.6 in.) SUL, with females maturing at a larger size than males (Kupferberg et al. 2009c, p. 34). Juveniles can remain active and grow during the winter (Rombough 2006b, p. 159), but grow very little (Storer 1925, pp. 255–256). During the breeding season following metamorphosis, wild juvenile frogs (i.e., yearlings) are still smaller than adults and do not breed (Storer 1925, p. 256; Zweifel 1955, p. 229). In most populations, female foothill yellow-legged frogs begin reproductive activity during their third spring post-metamorphosis; however, evidence suggests that in some central coast populations, females breed during their second spring (USFWS, 2023).

Adult: Throughout the range of the species, breeding takes place between late March and early July (Zweifel 1955, p. 228; Yarnell et al. 2013, pp. 64, 67, table 14), during the transition from wet season to dry season. Onset and duration of the foothill yellow-legged frog breeding season is plastic and closely linked to the natural hydrologic cycle (Wheeler and Welsh 2008, p. 128) and water temperature (Kupferberg 1996a, p. 1337; Wheeler et al. 2018, p. 294). Male frogs begin breeding vocalizations when water levels and flow rates decrease following rain and snowmelt runoff events (Wheeler et al. 2018, p. 293). In general, the initiation of breeding occurs during a gradual decrease in stream flow rate while water temperatures rise above 10 degrees Celsius (°C) (50 degrees Fahrenheit (°F)). Initiation of breeding activity and oviposition (i.e., egg-laying) is extremely variable among years and by geography (Wheeler et al. 2018, pp. 289, 292–293). Breeding may occur earlier during low base-flow years and later during high base-flow years (Kupferberg 1996a, p. 1337 (Eel River); Wheeler and Welsh 2008, p. 136 (Hurdygurdy Creek); Yarnell et al. 2013, p. 66, figure 41 (North Fork American)). However, studies in some locations suggest that initiation of breeding activity is more closely linked to photoperiod (i.e., day of the year) than to interannual variations in streamflow (Gonsolin 2010, p. 49). Temporary cessation of breeding activity has been observed when rain events increase stream flow (Wheeler and Welsh 2008, p. 136; Gonsolin 2010, p. 51). This may occur because higher flows submerge male calling sites and underwater velocities would be too high for oviposition (Wheeler and Welsh 2008, p. 136). In Oregon, larger populations (i.e., those with more than 100 breeding adults) consistently had longer periods of breeding activity than smaller populations and researchers potentially attributed the longer breeding season duration to the influence of population abundance (USFWS, 2023).

Habitat Type

Adult: wide variety of vegetation types including valley-foothill hardwood, valley-foothill hardwood-conifer, valley-foothill riparian, ponderosa pine, mixed conifer, mixed chaparral, and wet meadow (USFWS, 2023).

Spatial Arrangements of the Population

Adult: Clumped

Environmental Specificity

Adult: Narrow

Tolerance Ranges/Thresholds

Adult: Moderate

Site Fidelity

Adult: Moderate

Habitat Narrative

Adult: The foothill yellow-legged frog is a stream-obligate species that typically occurs from sea level to approximately 1,524 m (5,000 ft) (pers. comm. cited in CDFW 2019b, p. 8). The foothill yellow-legged frog occurs in a wide variety of vegetation types including valley-foothill hardwood, valley-foothill hardwood-conifer, valley-foothill riparian, ponderosa pine, mixed conifer, mixed chaparral, and wet meadow (Hayes et al. 2016, p. 5). The extensive range of the foothill yellow-legged frog demonstrates the species' non-specificity in regards to vegetation type and macroclimate of the species' terrestrial habitat component. Foothill yellow-legged frogs are primarily observed in or along the edges of streams (Zweifel 1955, p. 221; Kupferberg 1996a, p. 1339). Most foothill yellow-legged frogs breed along mainstem water channels and overwinter along smaller tributaries of the mainstem channel (Kupferberg 1996a, p. 1339; GANDA 2008, p. 20). Stream morphology is a strong predictor of breeding habitat because it creates the microhabitat conditions required for successful oviposition (i.e., egg-laying), hatching, growth, and metamorphosis. Foothill yellow-legged frogs that overwinter along tributaries often congregate at the same breeding locations along the mainstem each year (Kupferberg 1996a, p. 1334; Wheeler and Welsh 2008, p. 128). During the non-breeding season, the smaller tributaries, some of which may only flow during the wet winter season, provide refuge while the larger breeding channels may experience overbank flooding and high flows (Kupferberg 1996a, p. 1339). Habitat elements that provide both refuge from winter peak flows and adequate moisture for foothill yellow-legged frogs include pools, springs, seeps, submerged root wads, undercut banks, and large boulders or debris at high-water lines (USFWS, 2023). Foothill yellow-legged frogs appear to use different overwintering strategies in terms of seasonal movement and habitat type, even within a single population (Bourque 2008, p. 65). Generally, foothill yellow-legged frogs travel up along small tributaries where they become inactive for a period during the winter. However, foothill yellow-legged frogs may remain active during the winter if conditions are favorable (van Wagner 1996, pp. xix, 74). The foothill yellow-legged frog inactive period is variable among years and by geography, climate, and life stage. The inactive period, if it occurs at all, typically extends from mid-fall until late February or early March, with adults remaining inactive for longer periods than juveniles (Zweifel 1955, p. 226). Activity may begin earlier during mild winters and active individuals have been observed throughout the winter in the San Francisco Bay area (Zweifel 1955, p. 226). Compared to higher elevation populations, coastal populations and those in lower-elevations of the Sierra Nevada might be active for an extra month in the fall and extra month in the late winter; in the highest range elevations, the inactive period may be four or five months long (USFWS, 2023).

Dispersal/Migration

Dispersal

Adult: juvenile frogs were found dispersing into a residential neighborhood 16 to 331 m (52 to 1,086 ft) from the creek (USFWS, 2023)

Dispersal/Migration Narrative

Adult: In Mendocino County (North Coast California unit), juvenile frogs were found dispersing into a residential neighborhood 16 to 331 m (52 to 1,086 ft) from the creek (Cook et al. 2012, p. 325). In Tehama County (North Coast California unit), a radio-telemetered female traveled approximately 7 km (4.3 mi), using intermittent tributaries (some of which were dry with only moist substrates) and cresting a ridge (Bourque 2008, p. 30). Bourque (2008, p. 72) noted that adults at the Tehama County study site typically moved during hot and dry conditions but avoided desiccation by restricting travel routes to drainage networks with moist substrates (USFWS, 2023).

Population Information and Trends

Population Trends:

Declining (USFWS, 2023)

Number of Populations:

4 listed populations

Population Narrative:

Subpopulations are subject to periodic extirpation from demographic or environmental stochasticity, but then are naturally repopulated via colonization from nearby subpopulations. Therefore, it is more informative to look at species' status at the metapopulation level, which is more stable than the subpopulation level. A metapopulation is distinguished from an adjacent metapopulation by the rate of gene flow, with gene flow and recolonization rates being greater within a single metapopulation than between adjacent metapopulations. Given this definition, we can deduce that each of the six foothill yellow-legged frog genetic clades (2.6 Genetic Clades) contains one or more metapopulations that are unique to that clade. Often, metapopulations are separated by large distances (greater than typical dispersal distances) and/or unsuitable habitat, or by topological features that act as barriers to dispersal. Although there is information about distances moved by marked frogs (up to 1000's of m (Bourque 2008, p. 30; Gonsolin 2010, p. 38)) and the distances at which genetic differentiation can be observed (10 km (6.2 mi) (Dever 2007, p. 171;)), the actual boundaries of foothill yellow-legged frog metapopulations are largely unknown. Population models demonstrate how foothill yellow-legged frog population abundance can have a sizeable effect on extirpation probability (Kupferberg et al. 2009c, p. ix; Rose et al. 2021, p. 12, figure 5). However, the minimum abundance required for a foothill yellow-legged frog population to be viable (i.e., minimum viable population) over an extended period is unknown. Multi-year survey data show how the average abundance of breeding females per km varies drastically among populations (Rose et al. 2020, pp. 63–64, table 1). The highest abundances (>100 breeding females per km) have only been recorded in the North

Coast California unit (Rose et al. 2020, pp. 63–64, 76, table 1, figure 4). One of the most abundant foothill yellowlegged frog populations is along the Mad River (Humboldt County, North Coast California unit) where the average breeding female density was 259 per km for 2008–2019 (Green Diamond Resource Company 2020, in litt.). Egg mass abundance (i.e., proxy for number of breeding females) peaked in 2017 when 1,469 egg masses were counted within a 2.35 km stretch of the Mad River during a single survey (Green Diamond Resource Company 2020, in litt.). There are also populations that have exhibited long-term stability with much lower abundances, such as 18 breeding females per km, in some Central Coast unit streams (Rose et al. 2020, pp. 63, 76, table 1, figure 4). Locations where breeding female abundances are much lower (e.g., 5 per km) could be population sinks where female emigrants from nearby populations lay eggs but recruitment typically fails due to poor spawning and rearing conditions (USFWS, 2023).

Threats and Stressors

Stressor: Altered hydrology
Exposure:
Response:
Consequence:
Narrative: Dams and other waterway modifications alter the hydrology, temperature, and morphology of foothill yellow-legged frog stream habitat.

Stressor: Nonnative species
Exposure:
Response:
Consequence:
Narrative: Foothill yellow-legged frog viability can be negatively influenced by several nonnative animal species. The American bullfrog (Lithobates catesbeianus, also known as Rana catesbeiana), nonnative crayfish (Pacifastacus spp.), and nonnative fish (e.g., smallmouth bass (Micropterus dolomieu)) have all been linked to decreases in foothill yellow-legged frogs (Olson and Davis 2009, pp. 17–18; Hayes et al. 2016, pp. 49–51). The following subsections provide details on how these nonnative species influence the foothill yellow-legged frog at various life stages by increasing predation, competition, and/or disease transmission. Other nonnative species, such as the barred owl (Strix varia), might also negatively influence foothill yellow-legged frog viability but are not discussed in detail because of limited information. Barred owls are suspected to be an emerging threat to foothill yellow-legged frogs in the North Coast analysis units (D. Olson 2021, in litt.) because of their predation of ranid frogs.

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Consequence:
Narrative: Foothill yellow-legged frog viability can be negatively influenced by the presence of Batrachochytrium dendrobatidis (Bd; causative agent of chytridiomycosis), parasitic copepods, and water molds (Saprolegniaceae family).

Stressor: Sedimentation
Exposure:

Response:
Consequence:
Narrative: Sedimentation is a threat for foothill yellow-legged frogs because it reduces the availability of important habitat features including coarse rocky substrates, geomorphic heterogeneity, and interstitial spaces. Increased sedimentation can increase turbidity, impact food resources, or impede foothill yellow-legged frog egg mass attachment to substrate (Cordone and Kelley 1961, pp. 191–192; Ashton et al. 1997, p. 13). Fine sediments can also fill interstitial spaces between rocks, which provide shelter from high velocity flows, cover from predators, and sources of aquatic invertebrate prey.

Stressor: Agriculture
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Narrative: Agriculture is a source of threats to the foothill yellow-legged frog because of agriculture's role in habitat degradation, contribution of pesticides and pollutants to the environment, and role as a driver of other threats such as altered hydrology and nonnative species (Figure 26). Agricultural land uses have been linked to declines in foothill yellow-legged frog populations (Davidson et al. 2002, p. 1597; Lind 2005, pp. 19, 51, 62, table 2.2). Foothill yellow-legged frog presence is negatively associated with agriculture within 5 km (3.1 mi).

Stressor: Mining
Exposure:
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Consequence:
Narrative: Mining is a source of threats to the foothill yellow-legged frog because of its role in habitat destruction and degradation, pollution, and expansion of nonnative species (Figure 29). Several types of mining practices have negatively affected foothill yellow-legged frog habitat; these include aggregate, hard-rock, hydraulic, and suction-dredge mining.

Stressor: Urbanization, Roads, and Recreation
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Response:
Consequence:
Narrative: Urbanization, roads, and recreation can affect foothill yellow-legged frog viability directly through mortality, but they are also major sources of threats to the foothill yellow-legged frog because of their role in habitat destruction, degradation, and fragmentation; contribution of pesticides and pollutants to the environment; and their role as drivers of other threats such as altered hydrology, nonnative species, and disease transmission (Figure 30). Conversion or alteration of natural habitats for urban land uses has been linked to declines in foothill yellowlegged frog populations (Davidson et al. 2002, p. 1597; Lind 2005, pp. 19, 51, 62, table 2.2). Foothill yellow-legged frog presence is negatively associated with cities and road density (Davidson et al. 2002, p. 1594; Olson and Davis 2009, p. 22). Increases in urbanization and roads have been reportedly associated with foothill yellow-legged frog extirpations in the South Coast unit, possibly by facilitating the spread of Bd and nonnative species.

Stressor: Drying and Drought
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Response:
Consequence:
Narrative: Temporary drying of waterways (from anthropogenic water allocation and/or drought) is implicated in declines and extirpations of foothill yellow-legged frogs because it shortens the hydroperiod; negatively affects habitat elements that are hydrology-dependent; limits recruitment, survival, and connectivity; and exacerbates the effects of other threats (Figure 33, Figure 34). Periodic drying of waterways and/or drought occurs naturally in foothill yellowlegged frog habitat, particularly in the southern analysis units (South Sierra, Central Coast, and South Coast units) (Adams et al. 2017b, p. 10227), but frequency of drying and drought is increasing because of anthropogenic water use and the effects of climate change (Section 7.13). Breeding sites that completely dried during consecutive severe drought years had zero reproductive success (S. Kupferberg, pers. comm. cited in Wheeler et al. 2018, p. 296; M. Parker 2021, in litt.). As drying occurs, frogs become more concentrated in the remaining pools and thus, become more susceptible to competition (Moyle 1973, p. 21), predation (Storer 1925, p. 261; Moyle 1973, p. 21), and exposure to diseases and parasites (Kupferberg et al. 2009a, p. 529; Adams et al. 2017a, p. 11). Reduced flow volume is associated with increased Bd load in foothill yellow-legged frog habitat (Adams et al. 2017a, pp. 8, 11). Absence of strong winter flows enables bullfrogs to expand their spatial distributions, which also contributes to disease transmission (Adams et al. 2017a, pp. 1–2). Multi-year droughts can also lead to tree mortality, which in turn, increases wildfire risk.

Stressor: Wildfire
Exposure:
Response:
Consequence:
Narrative: The effects of wildfire on foothill yellow-legged frogs are not well understood and have not been directly studied (CDFW 2019b, p. 71). Anecdotally, foothill yellow-legged frog populations have shown signs of resiliency after low- to moderate-severity wildfires (Lind et al. 2003, p. 27; CDFW 2019b, p. 71). It is suspected that low-severity fires do not have any adverse effects on the foothill yellow-legged frog (Olson and Davis 2009, p. 24). In fact, wildfires may be beneficial to habitat quality by decreasing canopy cover and increasing habitat heterogeneity (Pilliod et al. 2003, pp. 171, 173; Olson and Davis 2009, p. 24). Direct mortality from scorching is unlikely given the species' aquatic nature and the sightings of foothill yellow-legged frogs immediately after wildfires.

Stressor: Extreme Flood Events
Exposure:
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Consequence:
Narrative: Strong winter flows from heavy precipitation are typical in Mediterranean climates and small floods can maintain and improve foothill yellow-legged frog breeding habitat (Lind et al. 1996, pp. 64–65; Lind et al. 2016, p. 269; Power et al. 2016, p. 719). However, extreme flood events that only occur every few decades have the potential to cause severe habitat destruction and extirpations (Figure 43), especially when combined with other threats.

Stressor: Predators and Competition
Exposure:
Response:

Consequence:
Narrative: A variety of native and nonnative species prey upon foothill yellow-legged frogs. Predators include amphibians, birds, crustaceans, fish, aquatic insects, mammals, and reptiles (CDFW 2019b, p. 23, table 1). During the juvenile and adult life stages, garter snakes (Thamnophis spp.) probably account for most of the predation of foothill yellow-legged frogs (Zweifel 1955, p. 225; GANDA 2008, p. 36) (Figure 44). Although nonnative predation (especially by bullfrogs, crayfish, and fish) is given more attention than native predation (Hayes et al. 2016, pp. 56–57), native predation is also a serious concern, particularly when tadpoles and frogs are concentrated in shrinking, disconnected pools.

Recovery

Conservation Measures and Best Management Practices:

-

Additional Threshold Information:

-
-

References

USFWS. 2023. Species Status Assessment Report for the Foothill Yellow-legged Frog (Rana boylii). , Version 2.11. April 2023. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California.

SPECIES ACCOUNT: *Spea hammondii* (Western spadefoot)

Species Taxonomic and Listing Information

Listing Status: Proposed Threatened

Physical Description

The western spadefoot ranges in size from 3.8 to 6.3 centimeters (cm) (1.5 to 2.5 inches (in.)) snout to vent length (Stebbins and McGinnis 2012, p. 156). They are dusky green or gray on their backs and often have four irregular light-colored stripes, with the central pair of stripes sometimes distinguished by a dark, hourglass-shaped area. The skin tubercles (small, rounded protuberances) are sometimes tipped with orange or are reddish in color, particularly among young individuals (Storer 1925, pp. 148–149; Stebbins 1985, p. 57; Stebbins and McGinnis 2012, p. 156). The iris of the eye is usually a pale gold. The abdomen is white in color without any markings. Spadefoots have a wedge-shaped, glossy black “spade” on each hind foot, used for digging. The call of western spadefoot is hoarse and snore-like, and lasts between 0.5 and 1.0 second (Stebbins 1985, p. 57; Stebbins and McGinnis 2012, p. 156). Spadefoots are distinguished from the true toads (genus Bufo) by their cat-like eyes (their pupils are vertically elliptical in bright light but are round at night), the single black sharp-edged “spade” on each hind foot, teeth in the upper jaw, and rather smooth skin (Stebbins 1985, p. 56; Stebbins and McGinnis 2012, p. 154). The parotid glands (large swellings on the side of the head and behind the eye) are absent or indistinct on spadefoots (Stebbins and McGinnis 2012, p. 154). There are currently no known morphological differences described in the literature between the northern Figure 1: Genetic clustering (A) and Nuclear DNA analysis (B) and Mitochondrial of Spea hammondii showing separation between Northern and Southern occurrences at the Transverse Range (dotted line) (Adapted from Neal et al. 2018). and southern western spadefoot clades, although no explicit examination of morphological variation has been conducted to date (USFWS, 2023).

Taxonomy

Spadefoot toads were historically considered members of the family Pelobatidae (Stebbins and McGinnis 2012, pp. 154–158). However, some sources have recently reclassified spadefoot toads to the family Scaphiopodidae (AmphibiaWeb 2020, unpaginated; Santos-Barrera et al. 2018, unpaginated). Two closely related genera of spadefoot toads have been recognized, Scaphiopus and Spea (Wiens and Titus 1991, p. 21). Western spadefoots are classified within the genus Spea (Crother 2017, p. 23), although many older literature sources reference Scaphiopus as their genus. Species relationships within Spea have been difficult to define due to morphological similarity among species. At least four species in the genus Spea are currently recognized; western spadefoot (Spea hammondii), plains spadefoot (Spea bombifrons), Great Basin spadefoot (Spea intermontana), and Mexican spadefoot (Spea multiplicata) (Wiens and Titus 1991, p. 21; Neal 2019, pp. 120–121; AmphibiaWeb 2020, unpaginated). The western spadefoot (Spea hammondii) was first described and named by Spencer F. Baird in 1859, from a specimen collected by Dr. J.F. Hammond near Redding, California (Baird 1859, p. 12). At that time up into the latter part of the 20th century, the species was regarded as having a broad geographic range from California to western Texas and Oklahoma with a distributional gap in the Mojave Desert of California (Storer 1925, p. 148). However, Brown (1976, pp. 12–14) identified morphological, vocalization, and reproductive differences between eastern (Arizona eastward) and western (California and Baja California populations) spadefoots, justifying species recognition for each. The California population retained the name Spea hammondii (with a common name of western spadefoot) while the remainder of the populations were designated as Spea multiplicata (Mexican spadefoot). This distinction was further supported by electrophoretic analysis conducted by Sattler (1980; pp. 605, 608–609), by allozymic and morphological analyses conducted by Wiens and Titus (1991, pp. 21, 25–26), Neal et al. (2018, pp. 939–940) using nuclear sequence data, and by Neal (2019, p. 120) using RADseq. (USFWS, 2023)

Historical Range

The historical range of western spadefoot is from the vicinity of Redding in Shasta County, California, southward to northwestern Baja California, Mexico (Stebbins and McGinnis 2012, p. 157). They have been found at sites from sea level up to 1,385 meters (m) (4,500 feet (ft)) in the Sierra Nevada foothills (Stebbins and McGinnis 2012, p. 157). In California, western spadefoot ranges throughout the Central Valley, and in the Coast Ranges and the coastal lowlands from San Francisco Bay southward to Mexico (Stebbins and McGinnis 2012, p. 157). In Mexico, western spadefoot occurs from the international border to approximately El Rosario near Mesa de San Carlos, but may occur even farther south in some of the larger arroyos (McPeak 2000, p. 15; Grismer 2002, pp. 84–85; iNaturalist 2020, unpaginated). Genetic analysis of nuclear sequence data and RADseq SNPs from the northern and southern populations of western spadefoot, divided by the Transverse Range, indicate two genetically distinct, allopatric clusters that likely make up two species (Neal et al. 2018, pp. 937–938; Neal 2019, p. 114). Figure 2 displays the range of the western spadefoot (map projections from CDFW's California Wildlife Habitat Relationships western spadefoot map in California and International Union for Conservation of Nature's projection), divided into the northern and southern western spadefoot clades (USFWS, 2023).

Current Range

Currently, the species is patchily distributed throughout its historical range. However, the western spadefoot is thought to be extirpated throughout most of the lowlands of southern California and from many historical locations within the Central Valley (Stebbins 1985, p. 67; Jennings and Hayes 1994, p. 96; Thomson et al. 2016, p. 133). In the northern western spadefoot range, the largest declines have been observed in the Sacramento Valley and San Joaquin Valley, while declines have been more modest in the Coast Ranges (Fisher and Shaffer 1996, p. 1387). A species distribution model for the northern western spadefoot range (north of Santa Barbara) found the areas predicted to have suitable habitat are patchily distributed along the foothills surrounding the Central Valley and in the southwestern quarter of the northern western spadefoot range including the Salinas Valley (USFWS, 2023).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food Source

Adult: Widely distributed

Food/Nutrient Narrative

Larvae: The larvae of plains spadefoots (Scaphiopus bombifrons) consume planktonic organisms and algae, fairy shrimp, and will scavenge dead organisms, including other spadefoot larvae (USFWS, 2023).

Juvenile: Adult, juvenile, and presumably larval western spadefoot consume food items that are also used by other co-occurring amphibians including: pacific tree frog (Pseudacris regilla), California tiger salamander (Ambystoma californiense), and western toad (Anaxyrus boreas) (Morey and Guinn 1992, p. 155). Therefore, resource competition may occur depending on food abundance. Availability of small invertebrate prey is necessary for the survival of western spadefoot adults, juveniles, and larvae. Both aquatic breeding pools and upland habitat contribute to the habitat necessary for western spadefoot foraging (USFWS, 2023).

Adult: Adult western spadefoot forage on a variety of small invertebrate prey. Stomach content examinations have found food that includes grasshoppers, true bugs, moths, ground beetles, predaceous diving beetles, ladybird beetles, click beetles, flies, ants, and earthworms (Morey and Guinn 1992, p. 155). Adult western spadefoot can consume 11 percent of their body mass during a single feeding (Dimmitt and Ruibal 1980b, p. 857). Adults must be able to acquire sufficient energy for their long dormancy period of 8 to 10 months in only a few weeks (Seymour 1973, p. 435; Dimmit and Ruibal 1980b, pp. 858–861). The specific food items consumed by western spadefoot larvae are unknown, but they likely need some food to persist. The larvae of plains spadefoots (Scaphiopus bombifrons) consume planktonic organisms and algae, fairy shrimp, and will scavenge dead organisms, including other spadefoot larvae (Bragg 1962, p. 144; Bragg 1964, pp. 17–23). Adult, juvenile, and presumably larval western spadefoot consume food items that are also used by other co-occurring amphibians including: pacific tree frog (Pseudacris regilla), California tiger salamander (Ambystoma californiense), and western toad (Anaxyrus boreas) (Morey and Guinn 1992, p. 155). Therefore, resource competition may occur depending on food abundance. Availability of small invertebrate prey is necessary for the survival of western spadefoot adults, juveniles, and larvae. Both aquatic breeding pools and upland habitat contribute to the habitat necessary for western spadefoot foraging (USFWS, 2023).

Reproduction Narrative

Adult: Spadefoots emerge from burrows to breed following rains in the winter and spring. Adults breed and lay eggs in aquatic pools. Tadpoles rely on aquatic pools and can speed up metamorphosis if necessary when pools begin drying (Feaver 1971, p. 53; Morey 1998, pp. 86–89). Larval development can be completed in 3 to 11 weeks depending on food resources and temperature, but must be completed before the pools dry (Burgess 1950, pp. 49–51; Feaver 1971, p. 53; Morey 1998, p. 86). Annual reproductive success varies with precipitation levels, with success being lower in drier years (Fisher and Shaffer 1996 pp. 1394–1395). Longer periods of larval development have been associated with larger size at metamorphosis and likely increased fitness (Morey 1998, p. 86). Pools that persist for longer periods permit longer larval development, resulting in larger juveniles with greater fat reserves at metamorphosis (Morey 1998, p. 86). Larger individuals of New Mexico spadefoot toads (Spea multiplicatus) have been found to have higher fitness level and survivorship (Pfennig 1992, p. 1408). During dry years there may be fewer pools available for breeding and a shorter time period for tadpoles to develop. The rate of reproductive success needed for a population of western spadefoot to persist is unknown. Individuals within a population must have aquatic breeding pools for reproduction to be successful. Vernal pools are the primary aquatic breeding environment for western spadefoot (Storer 1925, p. 153). Vernal pools are ephemeral wetland habitat that form in areas where rainwater is restricted from downward percolation due to an impermeable surface or subsurface layer (Keeler-Wolf et al. 1998, p. 9). The restrictive layer may be a hardpan, clay pan, or bedrock depending on geographic region and local geology. The pools fill during the rainy season, with inundation varying annually depending on the amount of rainfall. Typical pond depth is 2–48 cm (0.8–19 in) (Barbour et al. 2007, p. 23). Most vernal pools are concentrated on the alluvial terraces extending west from the base of the Sierra Nevada foothills, and elevated terraces adjacent to stream and slough channels within the Great Valley basin, basin rim, and margins of the Sacramento-San Joaquin Delta (Holland 1978, pp. 3–5). In the Coast Range vernal pools are known from Los Angeles County north to Contra Costa County (Service 2005, pp. I-9–I-10, I12). In southern California (Orange, Riverside, and San Diego Counties) and northern Baja California, Mexico, pools occur either on gently sloping mesas standing above the primary drainages or in valleys at the low end of a watershed (Bauder and McMillan 1996, p. 56; Service 1998, pp. 1–20). Although vernal pools are considered the primary aquatic breeding habitat, eggs and larvae of western spadefoot have been observed in a variety of permanent and temporary wetlands, both natural and altered, including non-flowing rivers, creeks, artificial ponds, livestock ponds, sedimentation and flood control ponds, irrigation and roadside ditches, roadside puddles, tire ruts, and borrow pits, indicating a degree of ecological plasticity (CNDDB 2019). Neither rates of survival nor reproductive success have been documented to fully understand the use and relative importance of altered habitats (USFWS, 2023).

Habitat Type

Adult: Both

Habitat Narrative

Adult: Vernal pools are the primary aquatic breeding environment for western spadefoot (Storer 1925, p. 153). Vernal pools are ephemeral wetland habitat that form in areas where rainwater is restricted from downward percolation due to an impermeable surface or subsurface layer (Keeler-Wolf et al. 1998, p. 9). The restrictive layer may be a hardpan, clay pan, or bedrock depending on geographic region and local geology. The pools fill during the rainy season, with inundation varying annually depending on the amount of rainfall. Typical pond depth is 2–48 cm (0.8–19 in) (Barbour et al. 2007, p. 23). Most vernal pools are concentrated on the alluvial terraces extending west from the base of the Sierra Nevada foothills, and elevated terraces adjacent to stream and slough channels within the Great Valley basin, basin rim, and margins of the Sacramento-San Joaquin Delta (Holland 1978, pp. 3–5). In the Coast Range vernal pools are known from Los Angeles County north to Contra Costa County (Service 2005, pp. I-9–I-10, I12). In southern California (Orange, Riverside, and San Diego Counties) and northern Baja California, Mexico, pools occur either on gently sloping mesas standing above the primary drainages or in valleys at the low end of a watershed (Bauder and McMillan 1996, p. 56; Service 1998, pp. 1–20). Although vernal pools are considered the primary aquatic breeding habitat, eggs and larvae of western spadefoot have been observed in a variety of permanent and temporary wetlands, both natural and altered, including non-flowing rivers, creeks, artificial ponds, livestock ponds, sedimentation and flood control ponds, irrigation and roadside ditches, roadside puddles, tire ruts, and borrow pits, indicating a degree of ecological plasticity (CNDDB 2019). Neither rates of survival nor reproductive success have been documented to fully understand the use and relative importance of altered habitats. Western spadefoots are almost completely terrestrial and enter water only to breed. During a majority of their life cycle, western spadefoots are dormant and estivate (summer dormancy), remaining in a torpor state in underground burrows in upland areas surrounding their aquatic (breeding) habitat (Ruibal et al. 1969, p. 581; Morey 2000, entire; Morey 2005, pp. 515– 516). This is a behavioral mechanism used by some amphibians to maintain moisture, slow metabolism, and avoid the excessive heat and dry period occurring from late spring through early fall when resources are limiting or environmental conditions are not favorable (Withers and Cooper 2019, p. 952). Research from spadefoots in southeastern Arizona (Spea multiplicata) has found that they remain dormant for 8 to 10 months in burrows 20–90 cm deep; during the approximate two-month active season, when spadefoots emerge at night from seasonal rains, they are found in more shallow underground burrows of approximately 2–10 centimeters (Ruibal et al. 1969, pp. 571, 575–583). As stated above, western spadefoots typically burrow approximately 1 m (3 ft) below ground during estivation (Stebbins and McGinnis 2012, p. 157). Spadefoots are able to dig their own burrows by digging backwards into soil using their foot spades (Stebbins and McGinnis 2012, p. 154). Burrow sites tend to have a high amount of duff or dead vegetation from previous years (Baumberger 2013, p. 25). Burrows are constructed in soils that are relatively sandy and friable as these soil attributes facilitate both digging and water absorption (Ruibal et al. 1969, p. 581; Baumberger 2013, p. 27). A certain level of moisture in the soil is required for burrowing individuals to avoid desiccation, but the required level of moisture is unknown. The permeable skin of the toads allows water absorption from the soil (Ruibal et al. 1969, p. 582). Spadefoots may retain urea to increase the osmotic pressure within their bodies, which prevents water loss to the surrounding soil and even facilitates water absorption from soils with relatively high moisture tensions (Ruibal et al. 1969, p. 582; Shoemaker et al. 1969, p. 585). The upland habitat which provides underground burrows are necessary in order for western spadefoot adults to survive. Western spadefoot may also create shallow burrows or use other animal burrows to provide shelter and cover during their above ground active season (Morey 1998, pp. 86–90; Morey and Guinn 1992, pp. 149–156). The availability of and access to suitable upland habitat likely influences the ability of adults to disperse and reproduce. If the upland habitat does not provide the capability to allow for underground burrows, is not accessible, or outside the dispersal capabilities of western spadefoot from aquatic breeding pools, then individual needs are not fulfilled (USFWS, 2023).

Dispersal/Migration

Dispersal

Adult: Western spadefoots must disperse between aquatic breeding pools and underground burrows during the breeding season. Adults disperse from underground burrows to aquatic breeding pools in order to reproduce. After the breeding season, adults and juveniles must disperse to underground burrows for shelter during the hot, dry summer. Seasonal rains are the environmental cue that initiates the breeding dispersal (Dimmitt and Ruibal 1980a, p. 26). Dispersal distances are heavily dependent on the amount of rain (Baumberger et al. 2020, pp. 1, 7–8). The maximum dispersal distance that has been recorded for western spadefoot is 605 m (1985 ft) (Baumberger 2020, pers. comm.). A study looking at movement of western spadefoot individuals in multiple Orange County breeding pools during a dry year found that the mean distance moved away from breeding pools was 69 (±60) meters (m) (75 yards (yd)), with the longest movement of an individual being 262 m (287 yd) (Baumberger 2013, p. 14). A study in Orange County on the same populations of spadefoot during a wet year found that the mean distance moved away from breeding pools was 137 m (±92) (150 yd), highlighting the difference that precipitation makes in maximum movement distances recorded (Baumberger et al. 2020, p.

17). The maximum upper 95 percent limit posterior predictive distribution for distance to breeding pool was 460 m (1509 ft) (Baumberger et al. 2020, p. 7). The western spadefoot needs opportunities for dispersal and interbreeding among multiple breeding pools. Dispersal between breeding pools creates metapopulations that allow for gene flow, which is vital for preventing inbreeding (Neal et al. 2020, pp. 26–28). Habitat corridors between breeding sites are necessary for continued gene flow. In order for dispersal to be successful, individuals in a population must have seasonal rains, aquatic breeding pools, and underground burrows available. The aquatic breeding pools and underground burrows must be within dispersal distance for the population to successfully reproduce (USFWS, 2023).

Population Information and Trends

Population Trends:

Declining (USFWS, 2023)

Representation:

Northern Western Spadefoot Clade Representation As described in the Methodology section (2.0), representation is the ability of a species to adapt to changing environmental conditions. This factor is assessed at the species level. The western spadefoot occurs across a wide physical range that has different environmental conditions and as a result, western spadefoot could be considered to have a high level of environmental adaptability. We typically use the breadth of genetic or environmental diversity within and among populations as a surrogate for evolutionary adaptability. As noted in the Genetics section and Species Needs section above, there is some degree of genetic differences between regions within the northern western spadefoot range (Neal 2019, p. 115). However, the low effective number of breeders in all regions of the northern western spadefoot clade suggests that there is low genetic variability, which may reduce the representation. The northern western spadefoot clade still occupies all known regions, but six of the ten regions are in low condition. Currently the species still has some degree of representation since it occupies all its historically unique ecological settings. However, with all of the regions with low or low-moderate resiliency, the probability of persistence in those regions may be compromised by the lack of one or more needs. Habitat loss in the range and limited breeding years due to recent drought has likely reduced the species representation from historical levels (Jennings and Hayes 1994, p. 96; Witham et al. 2014, entire; Vollmar et al. 2017, entire; Neal 2019, p. 32). With the amount of land that is protected for vernal pool habitat within the northern clade, we predict that the species will likely maintain some level of representation even if there was a decline in populations in regions with low condition (USFWS, 2023).

Redundancy:

Northern Western Spadefoot Clade Redundancy To assess the current condition of redundancy, the species’ current ability to withstand catastrophic events, this SSA considers the number of resilient regions in the northern western spadefoot range. We note that while more resilient populations are more likely to survive and rebound after a catastrophic even, numerous well-distributed populations with lower resiliency also contribute to redundancy. Resiliency is evaluated by assessing the condition of the individual and population needs for each region. There is a total of 10 regions in the northern western spadefoot range. Currently, four regions are in an overall low-moderate condition and six regions are in low condition with none of the regions in high or moderate condition. This may indicate that a majority of the regions have one or more individual or population needs that may be compromised. Of particular concern is that all the regions within the northern western spadefoot clade have a low condition for abundance which may make it difficult for them to withstand catastrophic events. However, the northern clade still occupies all regions throughout central and northern California. Environmental conditions throughout this areas varies greatly and most likely would still provide for the species needs, providing some redundancy even with regions in low condition (USFWS, 2023).

Threats and Stressors

Stressor: Development (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Both the northern and the southern western spadefoot clades likely suffered dramatic reductions in the mid to late 1900s when urban development and agricultural conversion were rapidly destroying natural habitats in the Central Valley and southern California (Jennings and Hayes 1994, p. 96; Thomson et al. 2016, p. 134). This loss of habitat associated with urban development and agricultural conversion has been attributed as the predominant change to western spadefoot abundance and distribution (Morey 2005, p. 515). Indirect impacts from development and land conversion includes habitat fragmentation, alteration, and degradation. Overtime such fragmentation, degradation, and alteration may cause ponded habitats to be less productive or be lost as breeding habitat for the western spadefoot (Service 2005, pp. I-16–I-28, II-232–II-234). In southern California, within the southern western spadefoot clade, by the early 1990s over 80 percent of the habitat once known to be occupied by western spadefoot had been developed or converted to uses that are incompatible with successful reproduction and recruitment (Jennings and Hayes 1994, p. 96). Soils supporting vernal pools within the southern western spadefoot clade were never extensive in comparison to the Central Valley of California, and large-scale development has significantly reduced vernal pool habitat in the southern western spadefoot clade (Bauder and McMillan 1996, p. 56; Service 2005, p. I-17). In northern and central California, within the northern western spadefoot clade, loss of habitat has been less severe, but estimates suggest that over 30 percent of the habitat once occupied by western spadefoot has been developed or converted to agriculture (Jennings and Hayes 1994, p. 96). Comparing extant vernal pool habitat from 2005 to 2012 within the northern western spadefoot clade, an estimated 6,758 acres (ac) (2,735 hectares (ha)) of vernal pool habitat were lost per year due to agricultural and urban development (Witham et al. 2014, pp. 1, 4–5). A total of 764,868 ac (309,532 ha) of vernal pool habitat was found to be extant in 2012, a loss of 42,952 ac (17,382 ha) since 2005 (Witham et al. 2014, p. 1). Development can directly destroy aquatic breeding pools and upland habitat, or it can alter the hydrology such that aquatic breeding pools may not form where they once existed. With the loss of aquatic breeding pools and upland habitat, abundance, dispersal, and reproduction within the northern and southern clades have been reduced because individuals no longer have the resources available to survive and disperse in order to reproduce (USFWS, 2023).

Stressor: Overabundance of Vegetation (USFWS, 2023)
Exposure:
Response:
Consequence:

Narrative: The plant community within the grassland landscapes in California has dramatically changed since European settlement of the area (Burcham 1956, pp. 81–85). These changes resulted from numerous factors including the reduction of wetlands, changes to native herbivore abundance and distribution, reduction of wildfire, and changes in vegetation from mostly perennial grasslands to annual nonnative species (Barry et al. 2006, pp. 7–9). Nonnative annual vegetation or overabundance of vegetation can degrade vernal pool habitat by intrusion into the ponded areas, increasing vegetative matter, or causing shortening of the hydroperiod of the pools (Clark et al. 1998, pp. 251–252; Marty 2005, pp. 1626–1632). As stated above, vernal pools make up the majority of aquatic habitat for the western spadefoot. Changes in vernal pool hydrology caused by overabundant vegetation may adversely affect western spadefoot populations. Overabundant vegetation is caused by both nonnative plant invasion as well as the lack of wild grazers on native vegetation. When there is too much vegetation around aquatic breeding pools, the vegetation absorbs the water and the pools dry more quickly. Grazing by both wild grazers and livestock grazers plays an important role in maintaining a balance of vegetation in areas with aquatic breeding pools. Removal of grazing has been found to reduce the inundation period of pools below the amount of time required for western spadefoot to successfully metamorphose (Marty 2005, p. 1626). An assessment of vernal pool habitats in the northern clade found that regions with no grazing had more invasive weeds that cause pools to dry more quickly (Vollmar et al. 2017, pp. 2–13). However, livestock may crush or even consume egg clusters while utilizing ponds and cause a minor amount of direct mortality to adult and juvenile toads through trampling. Additionally, in some soil types, particularly in southern California, grazing can impact the crust and cause an invasion of weeds rather than enhance vernal pools. Breeding habitat in the various regions experience unique threats and may need to be managed differently. Overabundant vegetation reduces the quality of aquatic breeding pools by causing them to dry more quickly, which then has impacts on reproduction and abundance (USFWS, 2023).

Stressor: Nonnative Predators (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Western spadefoots have many natural predators including, but not limited to, water birds, raptors, garter snakes, rattlesnakes, California tiger salamanders, and raccoons (Childs 1953, p. 228; Feaver 1971, pp. 44–45; Baumberger et al. 2020, p. 6). Natural predation is not known to be occurring at a higher than normal frequency on western spadefoot populations. However, there have been nonnative crayfish (Procambarus clarkia), mosquitofish (Gambusia affinis), African clawed frogs (Xenopus laevis), and bullfrogs (Lithobates catesbeianus) introduced within the range of both western spadefoot clades that have been found to be predators to western spadefoots (Hayes and Warner 1985, p. 109; Hayes and Jennings 1986, p. 490; McCoid et al. 1993, pp. 29–30; Jennings and Hayes 1994, p. 96; Fisher and Shaffer 1996, pp. 1389, 1392; Kuperman et al. 2004, p. 229; Touré et al. 2004, p. 2; Balfour and Ranlet 2006, p. 212; Peralta-Garcia et al. 2014, pp. 431–434; Thomson et al. 2016, p. 134; CaliforniaHerps 2023, entire). However, researchers looking at the diet of African clawed frogs at a site in Riverside, California, found the species' diet was mostly slow-moving invertebrates (McCoid and Fritts 1980, pp. 273–274). In an ephemeral aquatic habitat in southern California occupied by both the African clawed frog and western spadefoot, western spadefoots were still able to reproduce as confirmed by the presence of dispersing metamorphs (Ervin and Fisher 2001, pp. 265–266). All of the nonnative predators were introduced into California in the late 1800s and early 1900s, and

through range expansions, additional introductions, and transplants, these exotics have become established throughout most of the state (Fisher and Shaffer 1996, pp. 1392–1393). An inverse relationship has been observed between the presence of nonnative predators and western spadefoots (Fisher and Shaffer 1996, p. 1393). Nonnative predators may have displaced western spadefoots at lower elevations, resulting in western spadefoots being found primarily at higher elevation sites where predators are less abundant (Fisher and Shaffer 1996, pp. 1392–1394). Nonnative predators likely pose a greater threat to western spadefoot eggs and larvae given both life history needs and morphological and physiological differences between life stages. Adults and juveniles have an extended dormancy period which reduces interaction time with nonnative predators. Western spadefoot adults increase activity in response to moisture and low temperatures following storms, whereas bullfrogs increase activity in response to warmer temperatures prior to storms (Morey and Guinn 1992, p. 156). This may reduce the amount of contact and predation adult western spadefoots have with nonnative bullfrogs. In addition, toxic secretions from dermal glands of adult and juvenile spadefoots provide a significant deterrent to predators. However, nonnative species may also compete for resources with western spadefoots, thus potentially limiting adult and juvenile foraging success (Morey and Guinn 1992, p. 153). The extent to which nonnative predators are impacting western spadefoot populations is unknown. Nonnative predators can negatively impact the individual needs of small invertebrate prey, which can impact the abundance of western spadefoot populations because the number of individuals that can be supported by the food source would be compromised. Additionally, western spadefoots are prey for nonnative predators further reducing the abundance of populations. Figure 6 displays the known locations of nonnative species that may be impacting both clades of western spadefoot populations (USFWS, 2023).

Stressor: Drought (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: California's annual and seasonal precipitation patterns are extremely variable and dry conditions are common (California Department of Water Resources 2021, entire). Western spadefoots are adapted to dry conditions by both behavioral and physiological characteristics (see Species' Life History and Habitat, above; Service 2023, pp. 9–10). The U.S. Drought Monitor (a partnership of several Federal agencies and programs) gathers national precipitation information and categorizes normal and dry (drought conditions) into six categories of increasing dryness and severity from normal or wet conditions (None), abnormally dry (level D0), moderate drought (level D1), severe drought (level D2), extreme drought (level D3), and exceptional drought (level D4) (U.S. Drought Monitor 2023, entire). Portions of California within the western spadefoot's range has experienced extreme drought conditions (D3 conditions) in 2007– 2009, 2012–2014, and again in 2020–2021 (Williams et al. 2015, pp. 6823–6824; NOAA 2021a, entire) and exceptional drought conditions (D4 conditions) in 2014–2016 and 2021 (NOAA 2021a, entire). A drought condition of D3, corresponds to an area where major crop and pasture losses are common, wildfire risk is extreme, and widespread water shortages can be expected requiring restrictions. The D4 condition is more severe than D3 and corresponds to an area experiencing exceptional and widespread crop and pasture losses, wildfire risk, and water shortages that result in water emergencies (NOAA 2021b). Within the last 15 years portions of California within the western spadefoot's range have experienced extreme drought conditions (D3 conditions) in 2007–2009, 2012–2014, and again in 2020–2022 (Williams et al. 2015, pp. 6823–6824; NOAA 2021a and 2021b, entire; California Department of Water Resources 2022, pp. 2–4) and

exceptional drought conditions (D4 conditions) in 2014–2016 and 2021 (NOAA 2021a and 2021b, entire). Anthropogenic warming likely contributed to the 2012–2014 drought anomaly (Williams et al. 2015, pp. 6819, 6826). It is hypothesized that the recent extended drought periods have led to low effective population size in western spadefoot populations (Neal 2019, p. 32). Drought decreases the quality and quantity of aquatic breeding pools available for western spadefoots. Without aquatic breeding pools available, dispersal and reproductive opportunities are limited, ultimately reducing the abundance of the population. Small invertebrate prey that also depend on vernal pool ecosystems and the seasonal rains that create them are likely also negatively impacted by drought conditions (Colburn et al. 2008, pp. 120– 122). With a lifespan of only 5–6 years, individuals that experienced the 2007–2009 or the 2012– 2016 droughts likely had limited opportunities for breeding and feeding, likely contributing to the low effective population sizes that have been observed (Neal 2019, p. 32). Anthropogenic warming increases the overall likelihood of extreme droughts in California into the future (Williams et al. 2015, pp. 6819, 6826). Projected climate change conditions indicate an increased likelihood of more frequent, longer, and intense droughts in the future (USFWS, 2023).

Stressor: Chemical Contaminants (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Western spadefoots are exposed to a variety of toxins throughout their range, but the sensitivity and overall population impacts of the western spadefoot to pesticides, heavy metals, air pollutants, and other contaminants is largely unknown. Each year, millions of kilograms (millions of pounds) of fertilizer, insecticides, herbicides, and fungicides are used on crops, forests, rights of way, and landscape plants in California, including areas within the western spadefoot range (DPR 2017, p. 5). Some of these chemicals can be toxic to aquatic organisms including amphibians and their small invertebrate prey (Davidson 2004, p. 1892; Relyea 2005, p. 1118; Bruhl et al. 2013, p. 1). Industrial facilities and motor vehicles also release contaminants. Contaminants from road materials, leaks, and spills could contaminate the water in vernal pools. There is currently no evidence that chemical contaminants are impacting western spadefoots. Research looking into proximity of vernal pool habitat that may be impacted by pesticide drift and the presence of western spadefoot found no significant correlation between presence or absence of western spadefoot and the use of pesticides (Davidson et al. 2002, entire). Other than pesticide drift, there has been no research looking into other potential chemical contaminants that could be impacting vernal pool habitat. There is currently no other literature indicating impacts of chemical contamination and in the absence of evidence to the contrary, we do not consider chemical contamination a threat driving individual, population, or species level concerns (USFWS, 2023).

Stressor: Noise Disturbance (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Western spadefoots are sensitive to noise stimuli and break dormancy and emerge from their burrows in response to noise disturbance (Dimmitt and Ruibal 1980a, p. 26). Activities that produce low frequency noise and vibration, such as grading from construction and development activities, recreational off-road vehicle use, and seismic exploration for natural gas, in or near habitat for western spadefoot, may be detrimental to the species (Ouren et al. 2007, p.

20; Service 2005, p. II-234). Disturbances that cause western spadefoot to emerge at inappropriate times could result in mortality or reduced fitness (Dimmitt and Ruibal 1980a, pp. 27–28). Since western spadefoot are dependent on moisture from underground burrows to survive the hot and dry summers (Ruibal et al. 1969, p. 571), emerging when rains are not present may cause desiccation of individuals. Once western spadefoot break dormancy and emerge, individuals seek out small invertebrate prey to replenish energy stores. If western spadefoot individuals use the energy to emerge at inappropriate times, and prey species are not present, they may not have the energy available to return into underground burrows and resurface when conditions are appropriate (USFWS, 2023).

Stressor: Disease (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Western spadefoots are currently not known to be significantly impacted by any identified diseases, but there are known fungal and parasitic species that infect individuals in both DPSs. Chytridiomycosis (chytrid), a fungal skin disease caused by the pathogen Bd (Batrachochytrium dendrobatidis), impacts the young and juveniles of some species of frogs and other amphibians and eventually causes death. Chytrid has caused large-scale extirpation in susceptible amphibian species and occurs in the range of the western spadefoot (Weldon et al. 2004, pp. 2100–2104; Padgett-Flohr and Hopkins 2009, pp. 2–8). Bullfrogs, African clawed frogs, and native Pacific chorus frogs (Pseudacris regilla), known hosts of Bd, occur in the range of the western spadefoot. They are at least partially resistant to Bd and may act as a reservoir and vector for the disease (Reeder et al. 2012, pp. 1, 4–5; Eskew et al. 2015, pp. 515–516; Tinsley et al. 2015, pp. 380–381). Individual western spadefoots have tested positive for chytrid fungus (Batrachochytrium dendrobatidis), but widespread mortality from this disease has not been recorded (Fisher pers. comm. 2020). Out of 139 individuals that were tested for chytrid fungus, 116 tested positive (Fisher pers. comm. 2020). It has also been hypothesized that western spadefoot eggs may fail to develop potentially due to a fungus that thrives in warmer water temperatures and invades spadefoot eggs, and there have been documented cases of western spadefoot infected with nematodes (Storer 1925, p. 158; Brown 1967, p. 746; Goldberg and Bursey 2002, pp. 491–492). Other amphibians have experienced recent significant declines due to disease including chytrid fungus, white fungus (Saprolegnia ferax), ranavirus (Family Iridoviridae, Genus Ranavirus), bacterial infections, and trematodes (Daszack et al. 1999, entire; Densmore and Green 2007, entire; Wake and Vredenburg 2008, entire; Duffus et al. 2015, pp. 10–14). There is no evidence that indicates western spadefoot is significantly impacted by disease, but there are very few relevant studies and diseases such as chytrid can mutate and potentially create more virulent strains in the future (USFWS, 2023).

Stressor: Wildfire (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Wildland fires are a natural part of the environment within the range of the western spadefoot, however due to years of wildfire suppression, increased ignition sources, and climate change causing warmer and dryer conditions, more intense wildfires are occurring more frequently on the landscape (Keeley et al. 1999, entire). Within the range of the northern and southern DPSs of the western spadefoot, the areas most susceptible to wildfire are the foothill

regions of the Sierra Nevada Mountains and Coast Ranges as well as chaparral and coastal sage scrub habitats in southern California (Rochester et al. 2010, p. 342; Williams et al. 2019, pp. 896–906) that are outside the agricultural areas of the Central Valley (Sacramento Valley and San Joaquin Valley) and low-elevation urbanized areas of southern California (Thomson et al. 2016, p. 134). It is more likely for wildfires to impact populations in the coastal portions of the range and in southern California, and less likely for large wildfires to impact the portions of the range in the Central Valley of California (Thomson et al. 2016, p. 134). In a study examining pre- and post-fire amphibian capture rates, western spadefoots were found to have reduced capture rates post-fire in chaparral and coastal sage scrub habitats, indicating that wildfire may be impacting western spadefoot populations (Rochester et al. 2010, p. 342). Although wildland fire season typically coincides with the time of year western spadefoot individuals are dormant in underground burrows, high intensity wildfire may reduce the survival of individuals. If a wildfire was to occur during the dispersal period for western spadefoot, it may be particularly devastating for a population (Thomson et al. 2016, p. 134). In addition, wildfires may alter the hydrology of an area making it more or less suitable for aquatic breeding habitat during the wet season. Specifically, in the southern clade, vegetation changes that reduce habitat suitability are often the result of increased wildfire frequencies leading to type conversions of habitats overtime (e.g. native grassland or shrub/scrub to non-native grassland). Depending on the characteristics of the fire and time of year, the individual needs of aquatic breeding pools, upland habitat, and small invertebrate prey may or may not be reduced by wildfire. Wildfire likely reduces the abundance of a population (USFWS, 2023).

Stressor: Climate Change (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Western spadefoots are dependent on environmental conditions and seasonal weather patterns for supplying both feeding and breeding resources. The transition from estivation to emergence from underground burrows is linked to the vibrations from seasonal precipitation felt by western spadefoot in the fall and winter (Dimmitt and Ruibal 1980a, p. 26). Both foraging on small invertebrate prey and breeding in aquatic breeding pools occurs after western spadefoots emerge from burrows. As stated above, the aquatic pools must be a particular temperature for western spadefoot reproduction to be successful (e.g., 48 to 86 °F (9–30 °C)) (Storer 1925, p. 158; Brown 1967, p. 746); higher ambient temperatures can influence water temperatures. In addition, larval development and metamorphosis must be completed before pools dry (Burgess 1950, p. 49–51; Feaver 1971, p. 53; Morey 1998, p. 86). In California, annual average temperatures have increased by about 0.8 °C (1.5 °F) since 1895 (Kadir et al. 2013, p. 38). Additionally, extreme heating events have increased throughout the state (Kadir et al. 2013, p. 48). Furthermore, climate change likely contributed to the 2012–2014 drought anomaly discussed above which may be a contributing factor to low effective population size of western spadefoot populations (Williams et al. 2015, pp. 6819, 6826; Neal 2019, p. 32). Climate change will likely increase temperatures throughout the range of both western spadefoot clades into the future (Bedsworth et al. 2018, p. 22). In California, statewide models project warming of 2–4 °C (3.6–7.2 °F) (RCP 4.5, medium emissions scenario) to 4–7 °C (7.2– 12.6 °F) (RCP 8.5, business as usual scenario) by the end of the century depending on future greenhouse gas emissions (Pierce et al. 2018, pp. iv, 17–18). Although the mean annual changes in temperature will likely have impacts, in many ways the effects of climate change will be felt most strongly as extreme temperature events are predicted to increase (Pierce et al. 2018, pp. 18– 19). Modeled

changes in precipitation are more complex and projections are less clear than for temperature. The effects of climate change have significantly increased drought risk in the state (Diffenbaugh et al. 2015, p. 3931), leading to increased concern over the reliability of ephemeral vernal pool breeding habitat. Seasonal shifts to precipitation may also occur in California, with less precipitation in the early- to mid-fall (September/November) and more in early winter (December/January) (Pierce et al. 2018, pp. iv, 26, Figure 16). These shifts in precipitation may disrupt the timing of emergence and breeding for western spadefoot. Even if average precipitation were to occur within a year, it must occur over a period of time such that the aquatic breeding pools retain water for the eggs to hatch and larvae to become juveniles. In the Baja Peninsula of Mexico, a significant reduction of precipitation is expected as well as temperature changes larger than 2 °C (3.6 °F) warming by 2050 using downscaled regional climate modeling (Cavazos and Arriaga-Ramirez 2012, p. 5904). Climate change has and will likely continue to alter the temperature and precipitation regimes, generally making the environment warmer and dryer, having impacts on the individual needs of seasonal rains, aquatic breeding pools, and small invertebrate prey that will likely cause population impacts to reproduction, dispersal, and abundance (USFWS, 2023).

Recovery

Conservation Measures and Best Management Practices:

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Additional Threshold Information:

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References

USFWS. 2023. Species Status Assessment Report for the Western Spadefoot (Spea hammondii), Version 1.1. May 2023. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California.