SPECIES ACCOUNT: *Plestiodon egregius egregius* (Florida Keys mole skink)

Species Taxonomic and Listing Information

Listing Status: Proposed Threatened

Physical Description

The Florida Keys mole skink is a small lizard species isolated from the mainland and limited to islands of the Florida Keys (Figure 2). This species represents a unique genetic lineage, genetically distinct from the other Florida mole skink species (Brandley et al. 2005, pp. 387–388; Parkinson et al. 2016, entire). This skink is a slender, small brownish lizard with a brown, tan, or grey color, smooth, scales and two to four more pairs of light stripes extending from the head and neck that may reach the base of the tail. The tail, as in other species of mole skink, is brilliantly colored; individuals of the Florida Keys mole skink captured thus far have shown variations in tail color from orange and red to faded pink. This variation is likely due to age of the animal, as smaller individuals are observed with much more vibrant tails, transitioning to more subdued coloration as they grow. The small legs have five toes on each foot. Males display ventral and submental (under the chin) patches of pink and orange during the breeding season, although hints of these patches can be apparent throughout the year. Adults reach a total length of approximately 12.7 centimeters (cm) (5 inches (in)) (USFWS, 2022).

Taxonomy

The Florida Keys mole skink (Plestiodon egregius egregius) is one of five distinct species of mole skinks in Florida, all in the Genus Plestiodon (previously referred to as Eumeces) (Brandley et al. 2005, pp. 387–388). The other four species of mole skinks are the northern (P. egregius similis), peninsular (P. egregius onocrepis), blue-tailed (P. egregius lividus), and Cedar Key (P. egregius insularis) mole skinks. The northern mole skink is the most wide-ranging and has been documented in Florida, Alabama, and Georgia. The peninsular mole skink occurs throughout Florida. The bluetailed mole skink is restricted to the Lake Wales Ridge in central Florida, and the Cedar Key mole skink is restricted to the Cedar Key islands in the Gulf of Mexico (Mount 1968, pp.1–2) (Figure 2). Branch et al. (2003, pp. 202–205) reported that the Florida Keys mole skink is more closely related genetically to the blue-tailed mole skink than the peninsular mole skink. However, those Florida Keys mole skinks in the Upper Keys show morphological characteristics between the Florida Keys mole skink and the peninsular (mainland) mole skink (Christman 1992, p. 178). Recent genetic evidence supports a lack of interbreeding between the Florida Keys mole skink and the other mole skink species (USFWS, 2022).

Historical Range

The Florida Keys mole skink has been found in small numbers across the range of the Florida Keys (including the Distal Sand Keys region, including islands west of Key West to the Dry Tortugas) (Error! Reference source not found.; Table 2). The Florida Keys is a low-lying chain of small ancient coral reef islands (an archipelago) extending 201 km (125 mi) southwest from the southeastern tip of the Florida peninsula. The Florida Keys are primarily mangrove islands comprised of predominantly limestone substrate (ancient coral reef), with Key Largo limestone in the Upper Keys and Miami Limestone in the Lower Keys. The Florida Keys consist of approximately 1,700 islands connected by the Overseas Highway and many smaller outlying islands. The area covers approximately 360 square kilometers (km2) (139 square miles [mi2]) (Zhang et al. 2011, p. 3). The Marquesas Islands and Dry Tortugas are located approximately 35 km and 113 km (25 mi and 70 mi) west of Key West, Florida, respectively. The small islands of the Marquesas consist of an approximate 6.5 km2 (2.5 mi2) land area. The Dry Tortugas islands cover an area of approximately 259 km2 (100 mi2). The average elevation of the Florida Keys is less than one meter (3.2 ft.) above sea level. Windley Key in the Upper Keys is identified as having the highest elevation at approximately 5.5 m (18 ft.) above sea level (USFWS, 2022).

Current Range

The Florida Keys mole skink has been found in small numbers across the range of the Florida Keys (including the Distal Sand Keys region, including islands west of Key West to the Dry Tortugas) (Error! Reference source not found.; Table 2). The Florida Keys is a low-lying chain of small ancient coral reef islands (an archipelago) extending 201 km (125 mi) southwest from the southeastern tip of the Florida peninsula. The Florida Keys are primarily mangrove islands comprised of predominantly limestone substrate (ancient coral reef), with Key Largo limestone in the Upper Keys and Miami Limestone in the Lower Keys. The Florida Keys consist of approximately 1,700 islands connected by the Overseas Highway and many smaller outlying islands. The area covers approximately 360 square kilometers (km2) (139 square miles [mi2]) (Zhang et al. 2011, p. 3). The Marquesas Islands and Dry Tortugas are located approximately 35 km and 113 km (25 mi and 70 mi) west of Key West, Florida, respectively. The small islands of the Marquesas consist of an approximate 6.5 km2 (2.5 mi2) land area. The Dry Tortugas islands cover an area of approximately 259 km2 (100 mi2). The average elevation of the Florida Keys is less than one meter (3.2 ft.) above sea level. Windley Key in the Upper Keys is identified as having the highest elevation at approximately 5.5 m (18 ft.) above sea level (USFWS, 2022).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food/Nutrient Narrative

Adult: The Florida Keys mole skink preys on a variety of small insects (Hamilton and Pollack 1958, p. 26; Mount 1963, p. 364; Technical Team Working Group 2016, pers. comm.). Hamilton and Pollack (1958, p. 26) examined digestive tracts of 36 Plestiodon species including one sample from Key West and found ants, spiders, crickets, beetles, termites, small bugs, mites, butterfly larva, pseudoscorpion, and fungus. The make-up of diets has been shown to shift seasonally with prey relative to abundance. Prey is also thought to be caught and eaten underground (Mount 1963, p. 365). The recent surveys and field work by species experts indicate generalist and opportunistic (preying on those insects that are present and are of a size that the skink can ingest) feeding behavior by the Florida Keys mole skinks within their ground cover habitat (USFWS, 2022).

Reproductive Strategy

Adult: Oviparity (USFWS, 2022)

Reproduction Narrative

Adult: The generation time for the Florida Keys mole skink has not yet been documented. McCoy et al. (2010; pp. 641–642) used mark-recapture data with a similar species, the Florida sand skink (P. reynoldsi), to determine that 60 years represented 15 to 20 generations. These data illustrated that the previous estimate, based on the age at first reproduction, of generation length (30 to 37 generations in 60 years) for the Florida sand skink was underestimated (McCoy et al. 2010, pp. 642–643). The age at first reproduction for the Florida Keys mole skink and the Florida sand skink are similar (24 months compared to 19 to 22 months [McCoy 2010, p. 641], respectively) and may suggest a comparable generation time of approximately one generation every 3 to 4 years. Due to a lack of species-specific information, the following description of life history is based primarily on a closely related species, the red-tailed skink (Eumeces [now Plestiodon] egregius) work conducted in a laboratory setting (Mount 1963, entire). Scent is the most important factor in finding and selecting mates (Mount 1963, p.367). Mating of the Florida Keys mole skink typically takes place in fall or winter. Florida Keys mole skink has been observed mating during this time by field biologists surveying for the species (Technical Team Working Group 2016, pers. comm.). After mating the female enters a period of inactivity that last approximately one month (Mount 1963, p. 372). Eggs are laid under debris and usually in nest cavities. Female mole skinks den and attend their nests annually between April and June. The females lick, turn, and protect the eggs from predators. Research has shown that when any of these activities are prevented, the eggs are at risk of not developing normally (Mount 1963, pp. 376–377). Soils used for nesting are generally dry and unconsolidated to allow for the digging of nest cavities and their swimming movement through substrate. Nest depth is probably dependent upon substrate depth and is documented to vary greatly from 0.33 centimeters (cm) (0.13 in) to 1.83 meters (m) (6 ft) (Hamilton and Pollack 1958, p. 27; Neill 1940, p. 266). Based on laboratory research, an individual skink lays a clutch of 2 to 11 eggs with an average of 3 to 5 eggs (Bartlett and Bartlett 1999, p. 195; Mount 1963, p. 376). Eggs incubate for 31 to 51 days (Mount 1963, p. 376). No in-situ nests have been identified for the Florida Keys mole skink. Because of the predominantly limestone, prehistoric coral reef and rocky makeup of the archipelago, only a few areas provide the unconsolidated soils considered preferred by the Florida Keys mole skink for nesting. In the Florida Keys, the unconsolidated soil types are predominantly “Beach” and “Bahia Fine sand” and total only approximately 137.6 ha to 191 ha (340 ac to 472 ac) of soils in the archipelago (additional information on the distribution of these soil types in the Florida Keys is provided under “Habitat” below) (USFWS, 2022).

Habitat Type

Adult: Sand/Mangrove Islands (USFWS, 2022)

Site Fidelity

Adult: High

Habitat Narrative

Adult: For the purposes of this SSA, the Florida Keys have been geographically divided into the Distal Sand Keys, Upper Keys, Middle Keys, and Lower Keys. The Lower Keys comprise everything from Key West to Bahia Honda Key. The Middle Keys are Boot Key east to Long Key, and the Upper Keys are everything east of Long Key up to Key Largo and northward (Error! Reference source not found.). Additionally, the Distal Sand Keys include everything west of Key West, including Boca Grande, the Marquesas Keys, and Loggerhead Key in the Dry Tortugas. Loose soils that allow for “swimming” mobility through substrate are conducive to burrowing and nesting, and so the species requires, or highly prefers, loose soils (Christman 1992, p. 179).

Mount (1963, p. 359) identified the two key ecological factors affecting mole skink distribution as soil and moisture conditions and seldom encountered mole skinks where the soil was not well drained and friable. The Florida Keys mole skink has been found in wave-washed wrack, debris, and piles of rocks. They have also been found among rocks a few feet above the water on railroad embankments in the Upper Keys (Carr 1940, p. 75). Individual skinks have also been observed in shaded areas beneath stones in sandy areas of Key West and Stock Island (Duellman and Schwartz 1958, p. 289). The Florida Keys mole skink is documented in the beach berm zones and coastal hammocks in the Upper and Middle Keys (Monroe County 2016a, n.p.; Service 2021, n.p.). However, evidence suggests that the species can live in small areas of habitat or microhabitats within other mapped habitat types, including developed areas; individuals have been detected in developed areas of Key West (a backyard garden), Big Pine Key (along a road), and Key Vaca (in a landscaped area) and within pine rockland habitat on Big Pine Key (Emerick 2017a, pp. 4–5; iNaturalist 2020, entire). However, the vast majority of detections are within the beach berm habitat type and adjacent dunes (Emerick 2017a, p. 5). It is unknown how much of these small interior habitats exists, what they contribute to the overall species population sizes, and whether or not these interior microhabitats could serve to repopulate more coastal habitats following strong storms. It is possible that these storm events are what push the species into the more interior parts of the island (USFWS, 2022).

Dispersal/Migration

Motility/Mobility

Adult: High (USFWS, 2022)

Dispersal/Migration Narrative

Adult: There is a high confidence level among the herpetological experts that juvenile skinks establish a territory or home range away from their parents (Appendix B). Direct evidence is lacking on the Florida Keys mole skink home range distance. Schrey et al. (2011, p. 64) showed that sand skinks (P. reynoldsi) that were captured within 25 m (82 ft) of each other were genetically more similar (statistically significant) than other individuals who were beyond that distance. Because genetic differentiation requires time to develop, it shows a pattern of behavior in which individuals interbreed within 25 m (82 ft) of each other. In this study, the maximum distance used for captures in this study was limited to 25 m (82 ft) (Schrey et al. 2011, p. 60). Mushinsky et al. 2001 (p. 55) found that adult female sand skinks had an average dispersal distance of 23 m (75 ft). Maximum dispersal distances for sand skinks in Florida scrub habitat have been documented at 35 m (115 ft) upwards to 140 m (460 ft) although just a few adults were recorded at distances greater than 100 m (328 ft) (Gianopulus 2001, p.81; Mushinsky et al., 2001, p. 54). The larger home range distances of a few individual sand skinks beyond 100 m (328 ft) could be attributed to localized resource limitations or adult "floaters". As previously mentioned, the dispersal distance or typical home range for Florida Keys mole skink individuals has not been yet been studied but it is expected that the dispersal and home ranges are similar to that documented for the Florida sand skink. In general, male sand skinks have a slightly longer dispersal range than females to search for mates. Female sand skink dispersal distances are lower as they need to have soils for nesting and remain with the nest. Home range and maximum dispersal distances have been based on the findings of individual sand skinks. Dispersal distances ranged from 4.28 to 90 m (14.5 to 295.2 ft) (McCoy et al. 2020, p. 8). Capture-recapture data indicated an average home range of 219 +/- 80 m2, (radius of 44 to 95 ft) while the genetic analysis suggested a home range radius of 15 to 25 m (47 – 78 ft.)

(McCoy et al. 2020. P. 17). The total size of an area needed to support a population of of Florida mole skinks has not been defined. Also, the species structure of the Florida mole skink (five species) suggests limited dispersal for individuals of these species (Branch et al. 2003, p. 2007; Adler et. al. 1995, p. 535). There is a high likelihood that some level of stochastic passive dispersal of individuals, primarily via rafting (carried by floating debris and seaweed wrack) is occurring (Adler et al. 1995, pp. 535–537; Branch et al. p. 2003 p. 207; Losos and Ricklefs 2010, p. 360). Possible stochastic events leading to rafting or passive movement of skinks include: a) inundation and flooding of low-lying areas from strong seasonal storms and hurricanes that move debris or soils; and b) high tides and coastal storm surge that collect and carry wrack and vegetative mats. Distances between several islands with identified populations are relatively close: a) approximately 14.5 km (9 mi) from Boot Key, located on the northern end of the Overseas Highway, to Bahia Honda, the next nearest identified population; b) approximately 9.7 km (6 mi) from Bahia Honda to Big Pine Key; and approximately 25 km (15.5 mi) from Big Pine Key to Boca Chica, the most southern-identified population. Individuals may be dispersing (rafting) from one island to another often enough to maintain some interaction among the populations but still at levels low enough that the populations remain distinct (Cronin, 2003, p.1186; Smith and Green 2005, pp. 111–113). There are also small islets which lay between these mentioned islands. Based on genetic evidence, the species population structure is a set of multiple, non-interacting populations on separate islands. Additional information may find that its structure is some form of a classic metapopulation, with population extinctions and recolonization of new immigrants, to the degree that there are interactions (immigration and emigration of individuals) between islands (USFWS, 2022)

Population Information and Trends

Population Trends:
Declining

Number of Populations:
15 Current (USFWS, 2022)

Population Narrative:
we define 15 current, 5 recent, and 4 historical populations of the Florida Keys mole skink. “Current” populations represent those with detections from 2000 to present, “recent” populations have detections since 1970, and populations with detections only prior to 1970 are considered “historical.” Using our analysis of comparative population resiliency (Table A), we determined that four historical populations are likely extirpated, and five recent populations are possibly extirpated. Of the 15 current populations, only 3 can be confirmed to have high (2 populations) or very high (1 population) resiliency, all of which are in the Lower Keys. Five populations were determined to be moderately resilient, and seven are considered to have low resiliency (USFWS, 2022).

Threats and Stressors

Stressor: Climate change (USFWS, 2022)
Exposure:
Response:
Consequence:

Narrative: Sea Level Rise Climatic changes, including SLR and shifts in seasonal precipitation, temperature, and tropical cyclone intensities, are major threats to south Florida and to the Florida Keys. Since 1880, global sea level has increased by 0.20 m to 0.23 m (8 in to 9 in), and the rate of increase over the past 20 years has doubled (Service 2017, p. 5). An average 0.08 m (3 in) increase in overall global SLR has occurred between 1992 and 2015 (NASA 2015, p. 2). This rise is equivalent to the Florida coastline subsiding at a rate of 0.001 m (0.04 in) a year (Service 2017, p. 6). The long-term trend in SLR at the NOAA Key West Station shows a 0.0024 m (0.09 in) increase of the mean high water line (MHWL) per year from 1913 to 2015 (NOAA 2017a, p. 1) (Figure 7). The NOAA Vaca Key Station (City of Marathon) shows a 0.0035 m (0.14 in) per year SLR between 1971 (start of data collection) to 2015 (NOAA 2017a, p. 1) (Figure 4–2). Mean high water line is defined as, “The line on a chart or map which represents the intersection of the land with the water surface at the elevation of mean high water” Temperature and Precipitation In the United States, the average temperatures have increased by 0.77 C to 1.1 C (1.3 F to 1.9 F) since record keeping began in 1895 (Service 2017, p.2). The decade from 2000 to 2009 is documented as the warmest on record (since record keeping began in 1895) (Service 2017, p. 2). The average temperatures in south Florida have increased 0.83 degrees C (1.5 degrees F) or more since 1991 (Service 2017, page 2). Because of the current condition of human–induced emissions (that is, the pattern of continued release of GHGs added to those already occurring in the atmosphere), increases in surface air temperature continue to rise. Even if there was an immediate and aggressive reduction to all GHGs caused by humans, there would still be expected continued increases in surface air temperature due to the lag in response to GHGs by the Earth’s system (USFWS, 2022).

Stressor: Habitat Loss and Degradation (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: The habitat for the Florida Keys mole skink occurs as fragmented parcels across the islands of the Florida Keys. The current amount of land mass, suitable habitat, and suitable soils for the Florida Keys mole skink was identified earlier in Chapter 2.4, Habitat. The main islands of the Florida Keys (including Key West, Big Pine Key, and Marathon), are highly impacted by human development, but there are also areas of native habitat within the National Key Deer Refuge, Dry Tortugas National Park, State Parks (Long Key, Bahia Honda, Curry Hammock), and other undeveloped parcels that occur intermittently across the species range. These areas provide suitable habitat and soils for the Florida Keys mole skink (see Conservation Actions). While it is a small and highly impacted islandsystem, parcels of suitable habitat and soils remain which support the current distribution of this species. There is high uncertainty in the current and potential occupancy of the backwater islands by the Florida Keys mole skink. Current surveys on two relatively remote islands, Sawyer Key and Content Key, have recorded a few skinks (Error! Reference source not found.). Two skinks were documented on Sawyer Key in 2015, and one in 2016. Three skinks were documented on the same day in 2017 on Content Key. For this reason, these small islands also need to be considered as potential habitat under current condition (USFWS, 2022).

Stressor: Other Human Influences (USFWS, 2022)
Exposure:
Response:
Consequence:

Narrative: Collection The collection of Florida Keys mole skinks is considered low and an insignificant stressor on the species. A four year study on the commercial harvest of amphibians and reptiles in Florida documented the capture and sale of four Florida Keys mole skinks (two in 1990–1991 and two in 1993–1994) (Enge 2005, p. 211). Small skinks such as the Florida Keys mole skink are more often sold as snake food or captured incidentally during hunts for snakes (Enge 2005, pp. 198–211). A 2017 internet search for the sale of any Plestiodon skinks did not find any skinks for sale. Internet searches found two records of previously independent searches from 2013 and 2008 of consumers looking to purchase “mole skinks” (Fauna Classifieds 2017, n.p.; Yahoo answers 2017, n.p.). No responses to these inquiries were found. The collection of mole skinks would primarily target the adult and juvenile life stage. Adult female skinks are expected to be particularly vulnerable when attending a nest. Pesticides Current broad use of pesticides for mosquito control occurs in the Florida Keys. The Florida Keys Mosquito Control District includes centers in Key Largo, Marathon (Key Vaca), and Key West. Methods used include truck spraying, aerial adulticide and aerial liquid larvicide spray missions, and local community manual spraying (Florida Keys Mosquito Control District 2017, entire). The most common pesticides used for mosquito control in the Keys include Vectobac GS and WDG, Dibrom, Permanone 30–30 and Fyfanon ULV. There are specific “No–Spraying” zones throughout the Florida Keys that primarily consist of Refuge, Sanctuary, and state park properties as well as other tracts of undeveloped lands. Spray treatments appear to be concentrated in the larger populated cities and communities. This targeted method of mosquito control treatment affords some reduced exposure to the Florida Keys mole skink. The region-wide range of the mosquito control program could possibly be having an unidentified direct impact to the Florida Keys mole skink. Indirect effects could be occurring via impacts to their insect food sources, ground cover, and through soil absorption. Because of its widespread nature, the impact of mosquito spraying would be at the population and species level. At this time, no evidence exists to indicate that this activity is a negative stressor on the Florida Keys mole skink at the population or species levels. (USFWS, 2022).

Stressor: Predation, Competition, and Disease (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Predators Native snakes have been documented as natural predators on mole skinks (Hamilton and Pollack 1958, p. 28, Mount 1963, p. 356). The red cornsnake (Pantherophis guttatus) is known to be abundant in the Florida Keys and to frequently prey on lizards (Enge 2017, pers. comm.). There is no evidence of impacts to the Florida Keys mole skink by this snake. This predator-prey process has probably remained unchanged over time and currently presents no significant threat at the population or species level for the Florida Keys mole skink. Free-ranging feral cats (Felis catus) are actively managed via TNR in the Florida Keys where they co-occur with several endemic small mammals (Cove et al. 2018. p. 334). Feral cats are instinctively natural predators and have been documented killing a variety of lizard species including: eastern fence lizard (Sceloporus undulates), five-lined skinks (P. fasciatus), broad-headed skinks (P. laticeps), and ground skinks (Scincella lateralis) (Mitchell and Beck 1992, p. 200). Feral and all freeroaming cats present a significant threat to all life stages of the Florida Keys mole skink where they are present in skink habitat (Calver et al. 2011, entire). Direct evidence is lacking on the current level of impacts that feral and free roaming cats have on the Florida Keys mole skink. Given the limited dispersal and possibly clumped distribution, cat predation could negatively reduce or eliminate a skink population (FWC 2013, p.5). Invasive species The semi-fossorial

nature and small size of the Florida Keys mole skink makes all life stages, particularly the eggs, susceptible to the red imported fire ant (Solenopsis invicta). Fire ants have been documented killing numerous reptile species eggs and hatchings. Fire ants may also indirectly impact adults by affecting survival and weight gain, behavioral changes, changes in foraging patterns and habitat use, and reduced food availability (Allen et al. 2004, pp. 90–91). A study conducted in the Lower Keys, showed that transects closest to roads and which had the largest amount of development within a 150 m (492 ft) radius of a road had the highest probability of the presence of fire ants (Forys et al. 2002, p. 31). Fire ants could also be a food source for this insect–eating generalist, but this has not been documented and is not expected to be a preferred food source given the stinging capability of the ants. The brown anole (Anoles sagrei) and tropical house gecko (Hemidactylus mabouria) are non-native lizards that may be potential predators to the Florida Keys mole skink hatchlings. The northern curlytailed lizard (Leiocephalus carinatus, Peter's rock agama (Agama picticauda), giant ameiva (Ameiva ameiva), and Black spiny-tailed iguanas juveniles (Ctenosaura similis) are known to eat other lizards and are growing in numbers where they have been introduced (FWC 2016a; Enge 2021, pers. com.). The nonnative ashy geckos (Sphaerodactylus elegans) and the Florida reef gecko (S. notatus notatus) forage in leaf litter and may compete with the Florida Keys mole skink for food resources (Enge 2017, pers. comm.). The level of predation or resource competition that the Florida Keys mole skink species is experiencing from these invasive lizard species is unknown but not believed to be stressors to the population or species level. Nonnative plants have significantly impacted native habitats in south Florida (Bradley and Gann 1999, pp. 15, 72). Nonnative, invasive plants compete with native plants for space, light, water, and nutrients, and make habitat conditions unsuitable for mole skinks by changing or reducing leaf ground cover, increasing root masses in friable soils as well as loss of shade, and protective cover. If nonnative vegetation cover is not as dense as native vegetation, changes in soil temperature could result and negatively impact the Florida Keys mole skink (USFWS, 2022).

Stressor: Stochastic events (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Demographic stochasticity refers to random variability in survival or reproduction among individuals within a population (Shaffer 1981, p. 131). Demographic stochasticity can have a significant impact on population health, particularly for populations that are small, have low fecundity, and are shortlived. In small populations, reduced reproduction or temporary die-offs of a certain age-class will have a significant effect on the whole population. Although such impacts may have less of a consequence to a large population or to a (sub) species with many populations (high redundancy), this randomly occurring variation in individuals becomes an important issue for small populations. Environmental stochasticity is the variation in birth and death rates from one season to the next in response to weather, disease, competition, predation, or other factors external to the population (Shaffer 1981, p. 131). For example, drought or predation, in combination with a low population year, could result in extirpation. The origin of the environmental stochastic event can be natural or human-caused. Extreme events are expected to increase in strength and frequency with accelerated (USFWS, 2022).

Recovery

Conservation Measures and Best Management Practices:

-

Additional Threshold Information:

-
-

References

USFWS. 2022. Species status assessment report for the Florida Keys mole skink (Plestiodon egregius egregius). Version 2.0. April 2022. Atlanta, GA.

SPECIES ACCOUNT: *Plestiodon egregius insularis* (Cedar Key mole skink)

Species Taxonomic and Listing Information

Listing Status: Proposed Endangered

Physical Description

The Cedar Key mole skink is a small lizard subspecies known to occur only on the islands of the Cedar Keys along a ten-mile section of Florida's Gulf Coast. This subspecies represents a unique genetic lineage that is genetically distinct from the other four mole skink subspecies (Brandley et al. 2005, pp. 387–388; Parkinson et al. 2016, entire). The Cedar Key mole skink is a shiny brown lizard with small, well-developed legs; a pair of light, dorso-lateral stripes running the length of the body; and a light pink colored tail (Figure 3). This is the largest of the five subspecies with adults reaching a total length of approximately 15 centimeters (cm) (5.9 inches (in)) with the tail accounting for two-thirds of the length. (USFWS, 2023)

Taxonomy

The Cedar Key mole skink (Plestiodon egregius insularis) is one of five distinct subspecies of the mole skink, all in the genus Plestiodon (previously referred to as Eumeces) (Brandley et al. 2005, pp. 387–388). Analyses of mitochondrial DNA were used to determine phylogenetic relationships among Scincidae lizards and found Eumeces to be polyphyletic (a group of organisms derived from more than one common evolutionary ancestor or ancestral group and therefore not suitable for placing in the same taxon) (Brandley et al. 2005, pp. 387–388). Following these analyses, the genus name Plestiodon was designated for all species, including E. egregius, of the North American / east Asian Eumeces + Neoceps clade (Brandley et al. 2005, pp. 387–388). Therefore, we find that the best available scientific and commercial information indicate the Cedar Key mole skink is within the genus Plestiodon. The other four subspecies of mole skink are northern (Plestiodon egregius similis), peninsular (Plestiodon egregius onocrepis), blue-tailed (Plestiodon egregius lividus), and Florida Keys (Plestiodon egregius egregius) mole skinks. They are all restricted to sandy soil environments in Florida, Georgia, and Alabama. The northern mole skink is the most wideranging and has been documented in Florida, Georgia and Alabama. The peninsular mole skink occurs throughout much of peninsular Florida. The blue-tailed mole skink is restricted to the Lake Wales Ridge in central Florida, and the Florida Keys mole skink is restricted to the Florida Keys (Mount 1968, entire) see Figure 2. Mount (1965, entire) based the mole skink taxonomy on morphological characteristics of tail coloration, scale counts, and width of dorsal stripes. The Cedar Key mole skink has inconspicuous light stripes that neither widen nor diverge, ≤21 scale rows at mid-body, and a large size; tail color varies from dull, dark orange to maroon (Enge et al. 2017b, entire). Recent genetic research by the University of Central Florida Parkinson (Conservation Genetics) Laboratory indicates the Cedar Key mole skink subspecies is more closely related to the peninsular mole skink but also identifies a lack of interbreeding between the two subspecies (nor with the other three subspecies). (USFWS, 2023)

Historical Range

Historically (1951–1993), Cedar Key mole skinks were documented and collected from Airstrip Island, Dog Island, Seahorse Key, and Way Key. Specimens from the earliest surveys are the basis for the taxonomic determination of this subspecies of the mole skink (Mount 1965, entire). From 2004 to 2022, Cedar Key mole skinks have been documented from Airstrip Island, Seahorse Key, and Deer Island, and from six additional islands: Atsena Otie Key, North Key, Scale Key, Snake Key, and Cedar Point Island. Way Key and Dog Island have not had recent records. Despite being developed, patches of potential habitat exist on Way Key, and isolated populations may still occur. Additional hammock islands have been identified within the salt marshes of the Cedar Keys as having potential habitat, but they have not been surveyed (Moler, pers. comm. 2017). From 1951 to 2022, there are less than 250 vouchered and unvouchered records for the Cedar Key mole skink (Table 3). These records come from ten of the islands within the Cedar Keys: Airstrip Island, Atsena Otie Key, Cedar Point, Deer Island, Dog Island, North Key, Scale Key, Seahorse Key, Snake Key, and Way Key (Mount 1963, entire; Mount 1965, entire; Florida Fish and Wildlife Commision (FWC), unpublished data 2023). Records since 2001 have primarily come from the FWC Herpetological surveys. As part of a summer Ecology college courses, an annual opportunistic survey has documented the presence of Cedar Key mole skinks in association with the dry beach habitat and wrack material on Seahorse Key each summer from 2001 to 2017 (Sheehy pers. comm. 2017). (USFWS, 2023)

Current Range

The Cedar Key mole skink has been found in small numbers on ten of the islands of the Cedar Keys (Figure 4). This coastal complex of islands, tidal creeks, bays, and salt marsh is located along ten miles of Florida's central Gulf of Mexico coast in Levy County; 60 miles north of Tampa and 50 miles southwest of Gainesville. The Cedar Keys occupy approximately 50 miles2 of coastal habitats. The waters of the Gulf of Mexico, channels, bays, tidal creeks, salt marshes, sand flats, mud flats and oyster reefs, separate most of these sandy-soil islands from the mainland and each other. This area of Florida's coast is micro tidal (tidal range of 73 cm (29 in)) and is considered a low-energy coastal environment relative to wave energy. The Cedar Keys are low, sandy islands. Many of the smaller islands have low elevation profiles (less than ten feet); however, five of the ten islands where Cedar Key mole skinks have been documented have elevations greater than 15 feet (Error! Reference source not found.). The three islands where the Cedar Key mole skink were historically documented all have elevations greater than 20 feet. Seahorse Key has the highest elevation at 52 feet. (USFWS, 2023)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food/Nutrient Narrative

Adult: The Cedar Key mole skink preys on a variety of small insects (Hamilton and Pollack 1958, p. 26; Mount 1963, p. 364; Technical Team Working Group 2016). Mount (1963, p. 365) examined the gut content of skinks from Airstrip Island collected under tidal wrack and found almost entirely crustaceans. Amphipods were found in all specimens. One specimen had eaten a small fiddler crab. The only non-crustaceans found were two earwigs and a beetle larva. Mount (1963, p. 365) also examined gut contents of specimens from Seahorse Key under tidal wrack. He found no amphipods in any of the guts, but earwigs were in most of the specimens. Hamilton and Pollack (1958, p. 26) examined digestive tracts of thirty-six Plestiodon egregius subspecies

(P.e. similis, P.e. onicrepis, and P.e. egregius) and found crickets, beetles, termites, small bugs, mites, butterfly larva, pseudo scorpions, and fungus. The make-up of Plestiodon egregius subspecies diets has been shown to shift seasonally with the relative abundance of prey. Prey is also thought to be caught and eaten underground (Mount 1963, p.365). Recent surveys and field work by species experts indicate generalist and opportunistic (preying on those insects that are present and are of size that the skink can ingest) feeding behavior of mole skinks within their ground cover habitat (Technical Working Group, 2016; Appendix B). (USFWS, 2023)

Reproductive Strategy

Adult: Oviparity

Reproduction Narrative

Adult: The Cedar Key mole skink has three identified life stages: eggs, immature (juvenile), and adult. The immature stage is approximately one year from hatching to reproductively mature adult (fall of first year). Juvenile Florida Keys mole skinks, another mole skink subspecies, have only been found in beach habitats. It is unknown if the life stages of the Cedar Key mole skink is limited to a specific habitat. It is important to note that locating and capturing mole skinks is difficult because of their small size, cryptic nature, and low abundance. Observations may reflect survey bias of the coastal system. The generation time for the Cedar Key mole skink has not yet been documented. As such we look to a similar lizard species that occupies similar habitat in Florida that we have more ecological information and use as a surrogate for life history information. McCoy et al. (2010; pp. 641–642) used mark-recapture data to determine that 60 years represented 15 to 20 generations for the Florida sand skink (Plestiodon reynoldsi). The data illustrated that the previous estimate, based on the age at first reproduction, of generation length (30 to 37 generations in sixty years) for the Florida sand skink was underestimated (McCoy et al. 2010, p. 642–643). The age at first reproduction for the Cedar Key mole skink and the Florida sand skink are similar (twenty-four months compared to nineteen to twenty-two months (McCoy et al. 2010, p. 641), respectively) and may suggest a comparable generation time of approximately one generation every three to four years. The Cedar Key mole skink, one of five recognized subspecies of mole skinks, is under surveyed and little is known about its life history. The following description of life history is based primarily on red-tailed skink work conducted in a laboratory setting (Mount 1963, entire), but which subspecies not specified. Scent is the most important factor in finding and selecting mates (Mount 1963, p.367). Mating typically takes place in fall or winter. This mating period has been observed for the Cedar Key mole skink by field biologists surveying for the subspecies (Technical Team Working Group 2016). After mating, the female enters a period of inactivity that last approximately one month (Mount 1963, p. 372). Eggs are laid under debris and usually in nest cavities. Female mole skinks den and attend their nests between April and June. The females lick, turn, and protect the eggs from predators. Research has shown that when any of these activities are prevented, the eggs are at risk of not developing normally (Mount 1963, pp. 376–377). Soils used for nesting are generally dry and unconsolidated to allow for the digging of nest cavities and their “swimming” movement through the substrate. Nest depth is probably dependent upon substrate depth and is documented to vary greatly from 0.33 centimeters (cm) (0.13 in) to 1.83 meters (m) (6 ft.) (Hamilton and Pollack 1958, p. 27; Neill 1940, p. 266). Based on laboratory research, an individual skink lays a clutch of two to eleven eggs with an average of three to five eggs (Bartlett and Bartlett 1999, p. 195; Mount 1963, p. 376). Eggs incubate for thirty-one to fifty-one days (Mount 1963, p. 376). Age at maturity is unknown, but it can be inferred from the closely related blue-tailed mole skinks (Plestiodon egregius lividus) which bred for the first time in the fall of their hatch year in a laboratory setting (Mount 1963, p. 381). No in-situ nests have been identified for the Cedar Key mole skink. In a central Florida sandhill scrub habitat, Mount (1965, pp. 372–373) captured more P. egregius (subspecies not specified) females with greater regularity than males during February and March and more males than females in November through January. The spring months coincide with a period of heavy foraging by females (Mount 1963, p. 373). The sex ratio for the Cedar Key mole skink is uncertain at this time. The sex ratio for the sand skink, which has similar breeding behavior to the Cedar Key mole skink, has been documented at a 1:1 ratio (Gianopulos, 2001, pp. 23–24; Sutton 1996, p. 36). (USFWS, 2023)

Habitat Narrative

Adult: The Cedar Key mole skink inhabits and utilizes the beach and dry coastal hammock habitats in the Cedar Keys. Mole skinks require, or highly prefer, loose soils (Christman 1992, p. 179). Loose, sandy soils allow for “swimming” mobility through substrate and are conducive to burrowing and nesting. Mount (1963, entire) identified the two key ecological factors affecting mole skink distribution as soil structure and moisture conditions. He seldom encountered mole skinks where the soil was not well drained and friable (Mount 1963, p. 359). Mount (1963, p. 359-361) found mole skinks along sandy shorelines beneath tidal wrack on Airstrip Island and Seahorse Key. Most were found at or above the spring tide mark under wrack that was dry or mostly dry. Mount also found several skinks under piles of dead grass at the airport (Mount 1963 pp. 360–61). Recent surveys by FWC and others have documented mole skinks along the dry beach habitat (above the high tide) under dry wrack and other vegetative debris (Enge, pers. comm. 2017). (USFWS, 2023)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: There is a high confidence level among the herpetological experts that juvenile skinks newly establish a territory or home range away from their parents (Technical Team Working Group 2016). Direct evidence is lacking on the Cedar Key mole skink home range distance. Schrey et al (2011, p. 63) showed that sand skinks (Plestiodon reynoldsi) that were captured within 25 m (82 ft.) of each other were genetically more similar (statistically significant) than other individuals who were beyond that distance. Because genetic differentiation requires time to develop, it shows a pattern of behavior in which individuals interbreed within 25 m (82 ft.) of each other. In this study, the maximum distance used for captures was limited to 25 m (82 ft.). Mushinsky et al. (2001 p. 55) found that adult female sand skinks had an average dispersal distance of 23 m (75 ft.). Maximum dispersal distances for sand skinks (Plestiodon reynoldsi) in Florida scrub habitat have been documented at 35 m (115 ft.) upwards to 140 m (460 ft.) although just a few adults were recorded at distances greater than 100 m (328 ft.) (Gianopulus 2001, p.81; Mushinsky et al., 2001, p. 54). The larger dispersal distances of a few individual sand skinks beyond 100 m (328 ft.) could be attributed to localized resource limitations. As mentioned, the dispersal distance or typical home range for Cedar Key mole skink individuals has not yet been studied, but it is expected that the mole skink home range is similar to that documented for the sand skink. The overall high population structure found in the mole skink (five Florida subspecies) also supports limited dispersal for individuals of these subspecies (Adler et. al. 1995, p. 535; Branch et al. 2003, p. 2007). Home range and maximum dispersal distances have been based on the findings of individual red-tailed skinks. The total size of an area needed to support a population of skinks has not been defined. Preliminary genetic evidence indicates that little to no connectivity or breeding is taking place between the identified Cedar Key mole skink populations, suggesting that the population structure of the subspecies is that of discrete, non-interbreeding populations (Parkinson et al. 2016, entire; Technical Team Working Group 2016; Mercier, pers. comm. 2017b). This population structure is supported by the relatively limited dispersal and small home ranges assumed for the Cedar Key mole skink. Stochastic passive dispersal of individuals via rafting (carried by floating debris and seagrass/marshgrass wrack) is occurring is possible but highly unlikely to occur (Adler et al. 1995, pp. 535–537; Branch et al. p. 2003 p. 207; Losos and Ricklefs 2010, p. 360; Censky et al. 1998, p. 560). The distance between adjacent keys/island and mainland ranges from 1.4 to 6.8 miles (2.3 to 10.9 km) (Figure 5). Rafting as a dispersal mechanism is known to play a role for immigration/emigration of animals to new locations or other islands (Adler et al. 1995, pp. 535–537; Branch et al. 2003, p. 207), but the degree and success to which this mechanism plays on the Cedar Key mole skink in establishing new populations on unoccupied islands is unknown and evidence suggests it is highly unlikely to occur. (USFWS, 2023)

Population Information and Trends

Threats and Stressors

Stressor: Threats (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: The predominant stressors currently affecting the Cedar Key mole skink and its habitat are the shifts in climate occurring as a result of increasing greenhouse gas emissions (GHG). The longterm persistence of the Cedar Keys, Florida Keys, and Florida's barrier islands is being challenged by rising sea levels and shifts in seasonal climate patterns. The main stressors affecting the Cedar Key mole skink and its habitat are sea level rise, increased cyclone intensities, storm surges, high tide flooding, and shifts in seasonal patterns of rainfall and temperature. Sea Level Rise Since 1880, global sea level has increased by 0.20 to 0.23 m (8 to 9 in.), and the rate of increase over the past twenty years has doubled (Service 2017, p. 5). An average 0.08 m (3 in) increase in overall global SLR has occurred between 1992 and 2015 (National Aeronautics and Space Administration Jet Propulsion Laboratory 2015, p. 2). This rise is equivalent to the Florida coastline subsiding at a rate of 0.04 inches a year (Service 2017, p. 6). The long-term trend in SLR at the NOAA Cedar Key Station shows a 2 centimeter (cm) (0.08 in) increase of the mean high water line (MHWL) per year from 1914 to 2016 (NOAA 2017a) (Figure 7). Mean high water line is defined as "The line on a chart or map which represents the intersection of the land with the water surface at the elevation of mean high water (NOAA NOS 2023, np). (USFWS, 2023)

Stressor: Development (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: The habitat for the Cedar Key mole skink occurs on undeveloped barrier islands protected as conservation lands and as fragmented land parcels on two developed islands of the Cedar Keys archipelago. While it is a relatively small coastal ecosystem of 30 or more islands of varying size and elevations, suitable habitat and soils remain which support the current known distribution of this subspecies on eight islands. One of the eight islands known to be currently occupied, only Airstrip Island is developed. Way Key, the largest island within the Cedar Keys

where the Town of Cedar Key is located, is also mostly developed, but the Cedar Key mole skink population status there is uncertain. Deer Island is also occupied by Cedar Key mole skinks; it is privately owned with one dwelling and could be further developed with a small number (off-the-grid) dwellings. The remaining islands with known populations of Cedar Key mole skinks are undeveloped and protected as part of the Cedar Keys National Wildlife Refuge. There are other islands of the Cedar Keys that are also protected as conservation lands and some that are privately owned (all or in part) that remain undeveloped. There are approximately 500 acres (202 hectares) of suitable habitat on Airstrip Island and Way Key and 308 acres (124 hectares) contain 540 single family houses, 225 condominium units, 40 mobile homes, 5 multi-family parcels, 380 vacant residential parcels, and 34 commercial units/parcels; there are also 154 acres of roads and right of ways (utilities) including approximately 50 acres (20 hectares) of an airport complex (Frank et al 2014, pg. 81, Service 2017, pg. 76). The airport complex on Airstrip Island consists of a small private airport; individual skinks have been documented on the airport property along the beach areas and under dead grass adjacent to the runway. However, the airport management provides a level of protection to the habitat by restricting human access, so that normal airport activities will not greatly impact the Cedar Key mole skink (Service 2017, p. 27). We do note that stone rip rap has been placed along segments of the Airstrip Strip Island as erosion control and may affect the skink population there. Finally, approximately nine acres (3.6 hectares) of potential habitat on Way Key is public land designated as the Cedar Key Museum State Park. (USFWS, 2023)

Stressor: Disturbance (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Disturbance of skinks and suitable habitat and soils from human activities have been identified as a potential stressor. Although the Cedar Keys National Wildlife Refuge is managed to enhance conservation of wildlife including the skink and its habitat (see discussion under Conservation Measures below), approximately 35,000 to 40,000 people visit the Refuge every year with approximately 26,250 to 30,000 visiting the Refuge islands (Gude pers. comm. 2018). However, as also discussed below, this Refuge is designated as a Wilderness Area, which limits the activities allowed on the islands to low impact activities including walking, paddling, and fishing (Service 2011, p. 1). In addition, many parts of the Refuge islands are not accessible to walking or other human activities due to dense vegetation (Service 2011, p. 1). The public can visit any of the beaches on the Refuge islands except areas closed during bird nesting season (Gude pers. comm. 2018). Atsena Otie Key is the only island managed by the Refuge that is fully open (beaches and interior areas of the island) to the public with a marked trail system; however, the portions of the island (Gude pers. comm. 2018). Seahorse Key’s interior is only accessible to the public 4 to 5 days per year (Gude pers. comm. 2018). The remaining Refuge islands’ interior areas are all closed to public entry (Gude pers. comm. 2018). Still, for the Refuge islands’ beaches, walking and launching kayaks or canoes along the beach could cause disturbance to the skink’s behavior and habitat, but this activity is not likely to rise to a population level impact since the Cedar Key mole skink is mostly found under wrack litter above the high tide line on the beaches and within leaf litter in other habitats. By limiting use of human activities on Refuge lands, negative impacts or loss to the skink and its habitat on these lands are minimized. The Cedar Key Chamber of Commerce estimates that 100,000 people visit Cedar Key annually. Even with this number of visitors, the level of disturbance and the impacts are believed to be small because most of the focal activities are boating, fishing, and ecotourism, all of which mainly

occur in the water and not within suitable habitat for the skink. Except for armoring of shorelines to protect existing structures, the Cedar Key community is unlikely to have much impact on the Cedar Key mole skink. As to the armoring, the City of Cedar Key laws limit the use of vertical coastal armoring and promoting and incentivizing methods of maintaining the natural state, using living shorelines (City of Cedar Key 2016, pp. 182–183; Frank et al. 2014, pg. 116). Shoreline armoring could impact individual skinks and their habitat, but, given the City's preference of maintaining natural states, shoreline armoring is unlikely to occur and is therefore expected to have a minor impact on populations (USFWS, 2023)

Stressor: Storm Events (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: There has been a substantial increase in most measures of Atlantic hurricane activity since the early 1980s, the period during which high-quality satellite data are available. These include measures of intensity, frequency, and duration as well as the number of strongest (Category 4 and 5) storms (Walsh et.al. 2014, p. 20; Knutsen 2023, p. 1). Hurricane activity has been above normal since the Atlantic Multi-Decadal Oscillation (AMO) (the natural variability of the sea surface temperature in the Atlantic Ocean) went into its warm phase around 1992. The recent increases in storm strength are linked, in part, to higher sea surface temperatures occurring in the equatorial regions of the Atlantic Ocean where hurricanes form and move. Numerous factors have been shown to influence these local sea surface temperatures, including natural variability of the AMO, human-induced emissions of heat-trapping gases, and particulate pollution. The increased intensity of tropical storms and hurricanes result in higher storm surge and coastal flooding events, increasing HTF events annually and, thus greater impacts to coastal habitats than historically documented. Ecosystem resiliency is reduced when impacts by extreme and repetitive events occur (Service 2017, p. 7). Saltwater intrusion from storm surge and flood result in displacement landward to less suitable habitat and the loss of individual mole skinks. Flooding also affects the inland habitats as the unconsolidated dry soils become wet and compacted and thus affect Cedar Key mole skinks' ecological niche of swimming, burrowing, foraging and nesting. Cedar Key mole skinks are especially vulnerable when these impacts occur repeatedly without time to recover. Sufficient long-term monitoring of the Cedar Key mole skink subspecies and information on storm impacts to this subspecies are mostly lacking. Most surveys have been opportunistic to determine presence or absence. However, the storm impacts to habitats from Hurricane Hermine, which passed by the Cedar Keys in September 2016, were documented (Enge et al. 2017b, entire) (Figure 9). Overwash and erosion to the beach and coastal hammock were widespread. Vegetation became buried and the ground cover was greatly reduced from the storm surge (Figure 9). The beachfront of North Key lost most of the vegetative cover required for the Cedar Key mole skinks. (USFWS, 2023)

Stressor: Predators (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Native snakes have been documented as natural predators on mole skinks (Hamilton and Pollack 1958, p. 28, Mount 1963, p. 356). However, this predator-prey process has probably remained unchanged over time and therefore is currently not considered a stressor at the population or subspecies level for the Cedar Key mole skink. Feral and free-roaming cats are

instinctively natural predators and have been documented killing a variety of lizard species including eastern fence lizard (Sceloporus undulates), five-lined skink (Plestiodon fasciatus), broad-headed skink (Plestiodon laticeps), and ground skink (Scincella lateralis) (Mitchell and Beck 1992, p. 200). Cats present a significant threat to all life stages of the Cedar Key mole skink where they are present on the developed islands of Airstrip Island and Way Key. Given the limited distribution of Cedar Key mole skinks, cat predation could negatively reduce or eliminate a skink population (FWC 2013, p.5). (USFWS, 2023)

Stressor: Invasive Species and collection (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: The semi-fossorial nature and small size of the Cedar Key mole skink makes all life stages, particularly the eggs, susceptible to the red imported fire ant (Solenopsis invicta). Fire ants have been documented killing numerous reptile species' eggs, hatchlings, and adults (Allen et al. 2004, p. 90-92). Fire ants may also indirectly impact adults by affecting survival and weight gain, behavioral changes, changes in foraging patterns and habitat use, and reduced food availability (Allen et al. 2004, pp. 90–91). A study conducted in the Florida Keys showed that transects closest to roads and that had the largest amount of development within a 492 ft (150 m) radius of a road had the highest probability of fire ants being present (Forys et al. 2002, p. 31). Similar results could be expected on the islands of Airstrip Island and Way Key. Fire ants could also be a food source for these insect-eating generalists, but this has not been documented and is not expected to be a preferred food source given the stinging capability of the ants. Again, there is no direct evidence that fire ants have any significant impact on this subspecies. The impact of other invasive species preying on Cedar Key mole skink is unknown (Hamilton and Pollack 1958, p. 28, Mount 1963, p. 356); at this time, it appears that invasive species are not a stressor at the population or subspecies level for the Cedar Key mole skink. Nonnative, invasive plants can compete with native plants for space, light, water, and nutrients. At this time, nonnative, invasive plants are not considered a stressor at the population or subspecies level for the Cedar Key mole skink. 4.2.7 Commercial or Private Capture/Collection The collection of the Cedar Key mole skink is considered to be infrequent and an insignificant stressor on the subspecies. A four-year study on the commercial harvest of amphibians and reptiles in Florida documented the capture and sale of four Florida Keys mole skinks (two in 1990 to 1991 and two in 1993 to 1994) (Enge 2005, p. 211). Small skinks are more often sold as snake food or captured incidentally during hunts for snakes (Enge 2005, pp. 198-211). Current internet searches for the sale of any Plestiodon skinks did not find any skinks for sale (Amazon 2017; Ebay 2017). Online searches by FWS staff biologists found two records of previously independent searches from 2013 and 2008 of consumers looking to purchase mole skinks (Fauna Classifieds 2017; Yahoo Answers 2017). No responses to these inquiries were found. The collection of mole skinks would primarily target the adult and juvenile life stage. Adult female skinks are expected to be particularly vulnerable when attending a nest. (USFWS, 2023)

Stressor: Pesticides (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Current broad use of pesticides for mosquito control occurs in Levy County. Methods used include spraying adulticide and larvicide spray. There is a specific "No-Spraying" zone across

the range of the Cedar Key National Wildlife Refuge, and the Refuge can only be sprayed in events of public health emergencies. The region-wide range of the mosquito control program could possibly be having an unidentified direct impact to the Cedar Key mole skink. Indirect effects could be occurring via impacts to their insect food sources, ground cover, and through soil absorption. Because of its widespread nature, the impact of mosquito spraying would be at the population and subspecies level. At this time, no evidence exists to indicate that this activity is a negative stressor on the Cedar Key mole skink. (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 Cedar Key mole skink (Plestiodon egregius insularis). Version 2.0. October 2023.

SPECIES ACCOUNT: *Drymarchon corais couperi* (Eastern indigo snake)

Species Taxonomic and Listing Information

Listing Status: Threatened; 3/3/1978; Southeast Region (R4) (USFWS, 2016)

Physical Description

The longest of North American snakes; heavy-bodied and shiny blue-black overall; chin, throat, and sides of head variably suffused with cream, orange, or red; scales unkeeled (males may have partial keel on scales of the middorsal 3-5 scale rows); anal undivided; 17 scale rows at mid-body; 1 preocular; third from last upper labial distinctly narrowed at the top; adult total length usually 152-213 cm (to 263 cm), about 43-61 cm at hatching (Conant and Collins, Smith and Brodie 1982) (NatureServe, 2015).

Taxonomy

Drymarchon couperi was proposed as a distinct species by Collins (1991), based on previously published (but unspecified) morphological differences and application of the evolutionary species concept. Crother et al. 2008, citing Wuster et al. (2001) listed couperi as a species. Subspecies couperi was proposed as a distinct species by Collins (1991), based on previously published (but unspecified) morphological differences and application of the evolutionary species concept. Crother et al. 2008, citing Wuster et al. (2001) listed couperi as a species. This database accepts Drymarchon couperi as a species, however, further study is warranted (NatureServe, 2015).

Historical Range

Historical range extended throughout the lower Coastal Plain of the southeastern United States, from southern South Carolina through Georgia and Florida to the Florida Keys, and west to southern Alabama and perhaps southeastern Mississippi (NatureServe, 2015).

Current Range

Current range includes southern Georgia (most common in the southeast; see Diemer and Speake 1983) and Florida (widely distributed throughout the state, south to the Keys, though perhaps very localized in the panhandle; Moler 1985, 1992; see also Ballard 1992). The species is apparently very rare or extirpated in Alabama, Mississippi, and South Carolina. Recent reintroductions have been made in Florida, Alabama, Georgia, South Carolina, and Mississippi. One reintroduced population may be thriving in Covington County, Alabama (NatureServe, 2015).

Distinct Population Segments Defined

No

Critical Habitat Designated

No;

Life History

Feeding Narrative

Adult: Eats small mammals, birds, frogs, snakes, lizards, and other vertebrates of appropriate size. Rossi (1994, Herpetol. Rev. 25:123-124) reported a juvenile that had eaten a large slug. Active forager; often searches along edges of wetlands (Moler 1992) (NatureServe, 2015).

Reproduction Narrative

Adult: Copulation occurs primarily in fall and winter. Eggs are laid in May-June (also reportedly as early as April). Clutch size usually is 5-10. Hatchlings appear from late July through October. Females can lay fertile eggs after several years of isolation (Behler and King 1979, Moler 1992) (NatureServe, 2015).Reported sex ratios of eggs 1:1, but adult sex ratios favor males 1.54: 1 (USFWS, 2008).

Spatial Arrangements of the Population

Adult: Clumped (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Dependency on Other Individuals or Species for Habitat

Adult: Gopher tortoises (NatureServe, 2015)

Habitat Narrative

Adult: Habitat includes sandhill regions dominated by mature longleaf pines, turkey oaks, and wiregrass; flatwoods; most types of hammocks; coastal scrub; dry glades; palmetto flats; prairie; brushy riparian and canal corridors; and wet fields (Matthews and Moseley 1990, Tennant 1997, Ernst and Ernst 2003). Occupied sites are often near wetlands and frequently are in association with gopher tortoise burrows. Pineland habitat is maintained by periodic fires. Viable populations of this species require relatively large tracts of suitable habitat. Refuges include tortoise burrows, stump holes, land crab burrows, armadillo burrows, or similar sites. Eggs may be laid in gopher (Geomys) burrows (Ashton and Ashton 1981). See USFWS (1998) for further information (NatureServe, 2015).Clumped spatial arrangement of the population and low tolerance range are inferred from NatureServe, 2015 habitat and population information.

Dispersal/Migration

Motility/Mobility

Adult: High (USFWS, 2008)

Migratory vs Non-migratory vs Seasonal Movements

Adult: Non-migratory (NatureServe, 2015)

Dispersal

Adult: Moderate (USFWS, 2008)

Dispersal/Migration Narrative

Adult: USFWS (2008) notes that theses snakes can move considerable distances in a short time (2.2 miles in 42 days). Snakes return to their home dens to winter dens.Most snakes are not known to be migratory.

Population Information and Trends

Resiliency:

Current Condition Resiliency Summary: Of the 83 populations assessed for current conditions, 36% are extirpated and 9% are in very low condition. Thirty-four percent (34%) are in low to medium-low condition, 16% are in medium to medium-high condition, and 5% are in high condition (Table 5). The highly resilient populations are found in the central portion of the Peninsular Florida region (CF 1-11, CF 1-10 and CF 1-8) and the northern region of the Southeast Georgia region (GA 2-4) (Figure 23). Populations considered in medium condition are largely found in the North Florida region, the northern portion of the Peninsular Florida region and scattered smaller populations in Southeast Georgia and southern Peninsular Florida. The majority of the extirpated populations are in the western portion of the range in the Panhandle region and the western area of the Southeast Georgia region. Other extirpated populations occur along the eastern side of the North Florida region and in the southern extreme of Peninsular Florida. Low and Very Low resilience populations are found along the coasts and near extirpated populations (USFWS, 2019).

Representation:

From an ecological and genetic variably perspective, the contemporary distribution of the eastern indigo snake provides species' representation but has considerably decreased from its historical representation. Most notably are the loss of populations in the Panhandle region and a contraction of the distribution in the southern extent of the Peninsular Florida region, including the Florida Keys. In addition losses from the North Florida region may be particularly important for maintaining species diversity because of its geographic location where both the ecological and genetic gradients come together (USFWS, 2019).

Redundancy:

We assessed eastern indigo snake redundancy by evaluating the number of populations and the extent for both the historical and current distribution of populations. The total number of current populations is 53. Although there were 51 historical populations, the current abundance of populations represents fragmentation of the historically larger populations into multiple, smaller populations, especially in Peninsular Florida (Figure 21, see section 5.1). Thirty (30) of the historical 51 populations are extirpated (59%) (Appendix B, Table B3). Population extent has declined in all regions with a 48% decline across the species' historical range. Southeast Georgia has 1, and Peninsular Florida has 3 highly resilient populations as well as multiple medium resilient populations (Table 6). The Panhandle and North Florida regions have zero (0) highly resilient populations, thus limiting overall redundancy. This is important for the species, especially for the North Florida region, because loss of redundancy in these areas limits connectivity to the other regions. Of extant populations across all regions, 17% of the total population extent (area) has high, 34% has medium, 45% has low, and 4% has very low resiliency (Table 7) (USFWS, 2019).

Number of Populations:

53 wild 2 reintroduced (USFWS, 2024)

Additional Population-level Information:

Historically, the eastern indigo snake occurred throughout Florida and in the coastal plain of Georgia, Alabama, and Mississippi. Today, most natural populations are known to occur in northern and peninsular Florida and southeastern Georgia. The species is extirpated or very rare in southwestern Georgia and the Florida Panhandle and is considered extirpated from Alabama and Mississippi. However, recovery efforts are underway to reestablish populations in Alabama and the Florida Panhandle. It is difficult to delineate biological populations of the eastern indigo snake due to the species' large home ranges, secretive behavior, low densities, and other challenges associated with identifying population boundaries. However, over the past decade, progress has been made via research and monitoring efforts to better understand the needs of eastern indigo snakes to estimate potential populations across the current range. In the Species Status Assessment (SSA) Report for the Eastern Indigo Snake (Service 2019b), 51 extant populations and 2 reintroduced populations were delineated based on occurrence records buffered by the species' maximum home range width (Figure 1). Furthermore, population resiliency was assessed based on habitat fragmentation, habitat type, road density, and gopher tortoise (Gopherus polyphemus) populations2 (Table 1). An estimated 30 populations are considered extirpated, and the area occupied by (i.e., population extent) the species has declined significantly from the historical distribution (Table 2). Compared to the historical distribution, populations have become smaller and more fragmented (i.e., more, smaller populations rather than fewer, larger connected populations) (Service 2019b). Population areas and resiliency have not been reassessed since the 2019 SSA and therefore it is unclear how many populations are stable or exhibit an increasing population trend at this time. In this review we provide updates since the last 5-year review (Service 2019c) based on monitoring and research efforts. Updates are organized by the Representative Regions and Conservation Focus Areas described in the SSA (2019b) and referenced in the species recovery plan criteria (2019a). (USFWS, 2024)

Population Narrative:

The eastern indigo snake has been extirpated in Alabama and Mississippi and, since listing under the ESA its distribution has further contracted in other areas, particularly in the Florida Panhandle due to the decline of gopher tortoise populations (Enge et al. 2013). Wild collection of eastern indigo snakes for the pet trade and gassing of gopher tortoise burrows are no longer considered to be substantial threats although they still occur to some extent. Habitat destruction, modification, and curtailment, however, remain significant threats to the species' recovery and long-term viability. Since the last review (Service 2008), significant progress has been made in our understanding of the species' distribution, life history and habitat requirements which has supported development and implementation of conservation strategies for the species. This new information was summarized and assessed in the eastern indigo snake's recent SSA (Service 2019). Fifty-three (53) potential populations were estimated in the SSA (Service 2019). Of these populations, resilience was classified based primarily on habitat conditions as follows: 8 very low, 28 low to medium-low, 13 medium to medium-high, and 4 high. The overall current population resiliency is medium to low. Population growth rates are unknown due to the lack of data on this cryptic species. The contemporary distribution of the eastern indigo snake represents the species' known ecological and genetic diversity, but the redundancy of populations has decreased. Most notable are the loss of populations in the Panhandle region (includes parts of Alabama, Florida, Georgia, and Mississippi) and a contraction of the distribution in the southern extent of the Peninsular Florida region, including the Florida Keys. The Panhandle and North Florida regions have zero (0) highly resilient populations, thus limiting overall redundancy. (USFWS, 2019b)

Threats and Stressors

Stressor: Habitat Loss (USFWS, 1982)
Exposure:
Response:
Consequence: Population decline
Narrative: In addition to the total loss of habitat when land is converted to row crops or housing developments, much of the forested sandhill habitat in south Georgia and parts of Florida is being degraded so that its value as Eastern indigo snake habitat is greatly reduced. These areas are being protected from fire and allowed to grow an overstory that is to dense (USFWS, 1982).

Stressor: Killing/Collection (USFWS, 1982)
Exposure:
Response:
Consequence: Population decline/reduction in individuals
Narrative: This large, slow snake is an easy mark for those that kill snakes on site. In addition, the docile nature and handsome appearance of this nonvenomous snake give it a high value in the pet trade (USFWS, 1982).

Stressor: Loss of Gopher tortoise (USFWS, 1982)
Exposure:
Response:
Consequence: Population decline
Narrative: There is a serious concern that gassing of gopher tortoise burrows by rattlesnake hunters is likely to kill the eastern indigo snake (USFWS, 1982).

Stressor: Pesticides (USFWS, 2019b)
Exposure:
Response:
Consequence:
Narrative: Because the eastern indigo snake is an apex predator, pesticides that bioaccumulate (become more concentrated) through the food chain may present a potential hazard (Lawler 1977). For example, secondary exposure to rodenticides used to control black rats may result in mortality to eastern indigo snakes in developed areas (Speake 1993). Although Knafo et al. (2016) found that organochlorine (OC) pesticides and their by-products were all below detection limits in their eastern indigo snake blood samples, Lawler (1977) examined body fat where high accumulation of these compounds were detected. Both blood and fat samples may be needed to accurately document variable levels of OC exposure (Rainwater 2005). Herbicides used on crops or for silviculture may have negative effects on eastern indigo snake populations (Speake 1993). There are no documented cases of eastern indigo snake mortality from pesticide use. While there may be some indirect effects to individuals, negative impacts from pesticide use is not considered a threat to the species at this time (USFWS< 2019b)

Stressor: Climate Conditions (USFWS, 2019b)
Exposure:
Response:
Consequence:
Narrative: Changing climate conditions are likely to affect eastern indigo snakes. Sea level rise from climate change will impact coastal populations due to inundation of habitat and increased

saline environments. Florida has undergone drastic changes in size and shape over long geologic periods due to sea level changes that influenced the distribution and genetic diversity of the eastern indigo snake (Kyrsko et al. 2016b). Some eastern indigo snakes have been observed in saline habitats (mangrove swamp) (Metcalf 2017) suggesting the species has some tolerance to salinity. Habitat loss and degradation of today's landscape reduces connectivity and creates movement barriers. For example, Metcalf (2017) suggests that a heavily trafficked road (SR 951) at Rookery Bay Reserve may block snakes in this coastal population from escaping inland to avoid rising sea levels. Impacts of shifting temperatures and rainfall due to climate change are variable but may cause indirect effects, such as changes in dependence on gopher tortoise burrows for winter shelter sites and shifts in prey base. However, since the eastern indigo snake has a diverse diet, dietary needs for the snake will likely be met with changing climate conditions. Shifting temperature and rainfall can negatively affect the ability to conduct prescribed fire (Melvin 2018) which is an important management tool for maintaining good quality habitat. In the SSA, 22 eastern indigo snake populations were predicted to be impacted by sea level rise in the future with nine (9) populations losing more than 10% of their habitat and seven (7) predicted to become extirpated (Service 2019). To minimize risk of habitat loss from sea level rise and variable effects from changing weather, maintaining connectivity among habitat patches so that snakes can move in response to changing climate conditions will be essential for long-term viability. (USFWS, 2019b)

Stressor: Direct Mortality (USFWS, 2019b)
Exposure:
Response:
Consequence:
Narrative: Continued human population growth will increase the potential of eastern indigo snake mortality from both intentional and unintentional killing. This will likely occur from direct mortality by people and domestic animals, use of chemicals to control disease and pests, and road mortality. Deliberate killing of snakes is common (Andrews et al. 2008) and studies have shown that 3% of motorists intentionally hit reptiles (Ashley et al. 2007, Crawford and Andrews 2016). Life history traits such as the snake's diurnal nature, large body size and large home range size (that often results in the necessity of crossing roads), make them more susceptible to being observed and deliberately killed. An increase in the number of mortalities from vehicles on roads may result in declines or extirpation of populations. At a study site in Florida, researchers compared the catch-per-unit-effort during 1981to1983, and 2005 to 2009, and they found that the eastern indigo snake population had declined by greater than 95 percent (Godley and Moler 2013). Potential eastern indigo snake habitat did not appear to substantially decline or change in quality over the three decades of this study. The researchers suggested evidence supported cumulative, unsustainable mortality from vehicular traffic as a primary factor in the population decline (Godley and Moler 2013). Because of the cryptic nature of eastern indigo snakes and the difficulty surveying for them, many records are from sightings on roads, either dead on road (DOR) or alive on road (AOR). A preliminary summary of DOR/AOR data by Enge, Stevenson, Chandler and Elliott (unpublished data), noted in Georgia and Florida that over 200 snakes were observed on roads since the year 2000 with most of these sightings being DORs. These 200 snakes are likely only a very small fraction of the actual DOR/AORs because many go unreported and DORs are often scavenged by other animals. While eastern indigo snakes will cross roads, telemetry data indicate that they prefer areas away from roads (Breininger et al. 2012, Hyslop et al. 2014, Bauder et al. 2018). Breininger et al. (2012) found that eastern indigo snakes had relatively high survival in conservation core areas, but their survival was greatly reduced along

roads and in suburbs. They found study animals dead along roads, including individuals intentionally killed by humans (Hyslop et al. 2009c, Breininger et al. 2012). Hyslop et al. (2014) did not record any radio-tracked study snakes outside boundaries created by paved roads, but found two eastern indigo snakes not included in the telemetry study dead on these roads. The radio-tracked snakes were found to regularly cross unpaved roads. In central Florida, 13 radio-tracked snakes did not cross paved roads, but five DOR eastern indigo snakes were found during the study (Smith 2006). Bauder et al. (2018) suggested that eastern indigo snakes avoid larger paved roads (primary and secondary roads such as interstates and highways), but readily cross smaller paved roads (tertiary roads such as two-lane rural county roads). In populations with low numbers of individuals, any additional negative factors impacting populations could cause local extirpations. This is especially true in long-lived snakes, such as the eastern indigo snake, that make long-distance movements, have low reproductive rates, and have low natural densities. Models have demonstrated that protection of adult eastern indigo snakes, which are the age class most likely to be killed on roads, is the most important factor in survival of a population (Hyslop et al. 2012). (USFWS, 2019b)

Stressor: Chlorinated Pesticides (Updated) (USFWS, 2024)
Exposure:
Response:
Consequence:
Narrative: Because the eastern indigo snake is an apex predator, pesticides that bioaccumulate through the food chain may present a potential hazard (Lawler 1977). Recently, the presence of chlorinated pesticides in tissue samples of necropsied eastern indigo snakes was found to be higher at one of the Everglades restoration sites (Bogan et al. 2023) than previously reported in for agricultural sites in Georgia (Knafo et al. 2016). One individual exhibited lethal levels and died, while others exhibited much lower, likely non-lethal levels (Bogan et al. 2023). Past and present pesticide use in agricultural areas continue to be a concern for eastern indigo snakes. Additional surveillance and monitoring are needed to better understand the impact residual pesticides may have at population levels. (USFWS, 2024)

Stressor: Development (USFWS, 2024)
Exposure:
Response:
Consequence:
Narrative: Residential, urban, and industrial development continue to negatively impact eastern indigo snake habitat and populations, particularly in Florida where population growth and development pressures are high (Bolt et al. 2023). Generally, residential and urban development occur near or around already developed areas but has expanded rapidly in some areas. Industrial developments, such as resource mining for sand, limestone, phosphate, and heavy minerals, generally cause intensive land disturbance over relatively large, sometimes rural areas. Some research has shown that eastern indigo snakes are reluctant to disperse or move from preferred habitat areas during intense habitat modification from mining (Durso et al. unpublished data), challenging the assumption that snakes move out of harm’s way during habitat disturbance. Further, if snakes do move, habitat connectivity is essential to minimize risk of direct mortality from crossing roads and other edge effects. Large-scale solar energy developments are emerging as a significant threat to eastern indigo snake habitat. These large-scale developments (hundreds to thousands of acres in size) are often located in rural areas, sometimes in natural and ecologically sensitive habitats. Specifically, Florida and Georgia have seen a significant increase in

this type of development impacting gopher tortoise and eastern indigo snake habitat at much larger scales and frequency than other types of developments. Sandhill habitats that support gopher tortoises, eastern indigo snakes, and other at-risk species have been targeted for this type of development due, in part, to lower land values and revenue opportunities for private landowners to lease (or sell) their land to solar developers. Both state agencies in Georgia and Florida have numerous permits, permit applications, or inquiries for relocating gopher tortoises off sites that are being proposed for solar developments. However, if gopher tortoises are relocated, eastern indigo snakes are left without essential shelter, breeding, and nesting habitat because relocation of snakes is often not a feasible solution. While some efforts have been made to improve siting of future solar developments to avoid impacts to sandhill habitats (see GUSSSI 2024), overall impacts are expected to continue to increase into the future. (USFWS, 2024)

Stressor: Agriculture and Silviculture (USFWS, 2024)
Exposure:
Response:
Consequence:
Narrative: Agricultural (cropland) land uses have mixed effects on eastern indigo snake populations. In the northern extent of the species' range (i.e., Southeast Georgia, North Florida, Panhandle regions) where the species relies on gopher tortoise habitat to support essential life functions, intensive agricultural areas (i.e., annually tilled) are not inhabited by gopher tortoises (Herman et al. 2012) and therefore may not support eastern indigo snakes. However, gopher tortoises may be attracted to fallow areas after several years of crop abandonment (Service 2022). In general cropland is declining throughout the southeast (USDA 2024) and fallow cropland reinhabited by gopher tortoises may be increasingly important for supporting eastern indigo snake population connectivity or could become population "sinks" if not conserved or restored (i.e., converted to other, incompatible land use). In Peninsular Florida some agricultural areas (e.g., citrus groves 2018). However, as part of the Everglades hydrological restoration several large agricultural sites (>10,000 acres each) that support eastern indigo snakes are being converted to water reservoirs and stormwater treatment areas which are unsuitable habitat for eastern indigo snakes. Currently, eastern indigo snakes are being displaced during construction and flooding of these areas and snakes may be more likely to develop health issues due to stressful environments, such as habitat conversion (Bogan et al. 2023) (see Factor C below). The long-term impact conversion of agricultural lands from Everglades hydrological restoration projects on eastern indigo snake populations is uncertain. Managed forests (silviculture), especially open pine (Pinus spp.) habitats that support gopher tortoises, provide important habitat and habitat corridors for eastern indigo snake populations throughout the species' range. Historically, natural longleaf pine (Pinus palustris) habitats with periodic fire to maintain open conditions was a predominate forest type used by gopher tortoises and eastern indigo snakes in the northern portion of the species' ranges. Today most of the longleaf pine ecosystem has been lost to timber harvest, fire exclusion, and land use change. However, longleaf pine ecosystem restoration efforts across the eastern indigo snake range continue to improve habitat on both public and private lands. Other forest types including managed private timberland (i.e., pine plantations) may also provide important habitat for the species. Managed forests may replicate open pine habitat conditions at various stages throughout the management cycle (planting, mid-rotation treatments [fire, herbicides], tree thinning, and timber removal) and may support gopher tortoise and eastern indigo snake populations (Greene et al. 2019, Royal et al. 2022). However, gopher tortoises may abandon areas due to loss of herbaceous groundcover from increasing midstory and canopy closure (Hermann et al. 2002), which may reduce shelter,

breeding, and nesting habitat for eastern indigo snakes. Although gopher tortoises may have some flexibility to persist on sites with high tree canopy cover (McIntyre et al. 2019) the long-term effects of pine plantation management cycles on eastern indigo snakes are unclear. Impacts from heavy equipment used in forestry operations and road mortality or deliberate killing within forested recreational areas (e.g., Godley and Moler 2013) is an ongoing concern. At some sites gopher tortoise burrows have been impacted by forestry equipment. Although gopher tortoises have shown ability to dig out of damaged or collapsed burrows, most commensal species like the eastern indigo snake would not be able to dig out and could be entombed. Forestry Best Management Practices, if implemented, can improve wildlife conservation. For example, when using heavy equipment for forestry, Georgia Best Management Practices recommend flagging all tortoise burrows and establishing a buffer of 10 feet (GDNR 2024) and Florida Best Management Practices recommend avoiding burrow impacts and marking concentrations of burrows (FDACS 2024). However, Best Management Practices are not always implemented. Forest certification programs (e.g., American Tree Farm, Sustainable Forestry Initiative, and Forest Stewardship Council may improve wildlife conservation and Best Management Practices monitoring and implementation. While managed forests (pine plantations) likely provide important connectivity among seasonal habitats (i.e., areas occupied by gopher tortoises and wetland areas) used by eastern indigos snakes, forests that are managed for open canopy conditions that support and protect gopher tortoise populations and their burrows are essential for long-term eastern indigo snake species viability (USFWS, 2024)

Recovery

Reclassification Criteria:
Maintain and protect existing populations (USFWS, 2008).

Reestablish populations where feasible (USFWS, 2008)

Improve public attitude and behavior towards the eastern indigo snake (USFWS, 2008)

Recovery Priority Number: 11C

Delisting Criteria:
The eastern indigo snake should be considered for removal from the List of Endangered and Threatened Wildlife when: 1) At least fourteen (14) populations exhibit a stable or increasing trend evidenced by natural recruitment, and multiple age classes (Addresses Factors A, C, and E). 2) Populations (as defined in criteria 1) are distributed across at least 12 Conservation Focus Areas (CFAs) (see Appendix A) with at least 2 populations within each of the 4 representative regions (North Florida; Panhandle; Peninsular Florida; Southeast Georgia) (Addresses Factors A, C, and E). 3) Populations within the North Florida, Peninsular Florida, and Southeast Georgia regions naturally maintain their genetic and ecological diversity (Addresses Factors A, C, and E). 4) Conservation measures (e.g., habitat protection and management) and commitments are in place to manage threats of habitat loss, degradation and fragmentation such that sufficient habitat quantity and quality exists for the species to remain viable into the foreseeable future (Addresses Factors A, C, D and E) (USFWS, 2019).

Recovery Actions:

- The viability of existing populations is unknown. Sites with historical and/or current populations are considered to be supporting populations of the snake. Protection needs to be pursued for populations occurring on privately owned land (USFWS, 2008).
- Initial efforts to establish populations have been deemed unsuccessful. Current efforts will be focused on one site in Alabama and will involve a soft release of juveniles into pens incorporating both wetland and upland habitat (USFWS, 2008).
- Meetings and other forms of public outreach have been developed to help inform the public of the beneficial nature of snakes in the environment. In addition many developers in Florida have designed programs for workers to help protect eastern indigo snakes that may be encountered on construction sites (USFWS, 2008).
- 1. Protect existing eastern indigo snake populations via land protection and appropriate habitat management and conservation techniques identified in site-specific management plans. 2. Monitor known eastern indigo snake populations and the habitat that supports them. 3. Expand knowledge of basic ecology and demography of eastern indigo snakes. 4. Repatriate populations within habitat historically occupied by eastern indigo snakes where feasible. 5. Develop range-wide habitat suitability models incorporating pertinent results from a Population Viability Analysis (PVA). 6. Establish a centralized range-wide Geographic Information System (GIS) database for data storage, analyses, and recovery review. 7. Develop and distribute public educational materials and outreach programs supporting eastern indigo snake recovery. 8. Coordinate all recovery activities, evaluate success, and revised recovery plan as appropriate (USFWS, 2019).

Conservation Measures and Best Management Practices:

- Federal Lands Agency Conservation Measures: Under section 7(a)(1) of the ESA Federal agencies are required to use their authorities to further the conservation of listed species. The Service, the Forest Service and the Department of Defense all play important roles in recovery efforts for the eastern indigo snake. Fish and Wildlife Service (Service) Because most species spend at least part of their lifecycle on non-federal lands, the Service implements conservation tools and programs that aid in the conservation of listed and at-risk species, including the eastern indigo snake, on non-federal lands. The Cooperative Endangered Species Conservation Fund (aka. Section 6 Grants) is a tool that provides grants to states to participate in a wide array conservation projects for listed species and species identified in State Wildlife Action Plans, which include the eastern indigo snake. These grants are State Wildlife Conservation Grants, Recovery Land Acquisition Grants, Habitat Conservation Planning Assistance and Land Acquisition Grants. Additionally conservation programs such as the Safe Harbor Program and Partners for Fish and Wildlife Program provide resources and financial assistance to private landowners to further conserve wildlife and their habitat. To date more than 100 Partners for Fish and Wildlife Project have been implemented across Alabama, Florida and Georgia that potentially benefit the eastern indigo snake Several National Wildlife Refuges (NWR) (e.g. Okefenokee NWR, Merritt Island NWR, Chassahowitzka NWR) provide important habitat for eastern indigo snake populations. Much of the prescribed burning and mechanical upland habitat restoration conducted NWRs have benefited the eastern indigo snake and made significant contributions to the survival and recovery of the species. Habitat improvements, including ecosystem restoration, enhancement, and protection, also support eastern indigo snake recovery. Forest Service National Forests in Alabama, Florida and Mississippi within the range of the eastern indigo snake have active prescribed burning programs for longleaf pine. This habitat management supports recovery efforts for the species. A multi-agency effort is occurring on the Conecuh National Forest to repatriate the eastern indigo snake to southern Alabama, as discussed below. The Forest Service has coordinated on this project with ADCNR, GDNR, Auburn University, The Orianne Society, Zoo Atlanta, Fort Stewart Military Reservation, and the Service (ADCNR 2014). Department of Defense As part of implementation of the Sikes Act Improvement Act (1997), the Secretaries of the military departments are required to prepare and implement Integrated Natural Resource Management Plans (INRMP) for each military installation in the United States. Those written for installations where the eastern indigo snake occurs include specific guidelines for conservation of the species. Eastern indigo snakes are known from at least seven military installations; 3 in Florida (Avon Park Air Force Range, Camp Blanding Military Reservation and Eglin Air Force Base [historical]) and 4 in Georgia (Fort Stewart Military Reservation, Kings Bay Navy Base, Moody Air Force Base [historical], and Townsend Bombing Range). An active prescribed burning program is implemented on these military installations to manage for longleaf pine ecosystems which benefits conservation and recovery of the eastern indigo snake. Many installations include specific eastern indigo snake habitat and population management prescriptions and goals within their INRMPs. In southeastern Georgia, research and management efforts have been on-going at the Fort Stewart Military Reservation where several populations of eastern indigo snakes are protected. In addition, ongoing environmental awareness training programs for soldiers include instruction on identification and protection of eastern indigo snakes. The Department of Defense's (DoD) Readiness and Environmental Protection Integration (REPI) program, also offers opportunities to expand land conservation beyond installation boundaries to improve military training flexibility by defending against incompatible development and reducing regulatory restrictions that inhibit military activities. Working through landscape partnerships, the DoD REPI program has helped protect additional eastern indigo snake habitat in Georgia and Florida. 4.8.3 State Wildlife Agency Conservation Measures Alabama, Florida, and Georgia wildlife agencies, often in coordination with the Service, have conducted surveys, longleaf pine ecosystem restoration projects, land acquisition, prescribed burning, and other activities to benefit the recovery of the eastern indigo snake on state and private lands. Specifically, GDNR is conducting annual mark-recapture monitoring across the eastern indigo snake range in Georgia. The program to repatriate eastern indigo snakes to Alabama and Florida (discussed below) was initiated by the ADCNR and the Florida Fish and Wildlife Conservation Commission (FWC) and supported by GDNR. The work of GDNR nongame staff resulted in the conversion in 2012 of an annual rattlesnake "roundup", within the range of the eastern indigo snake, to a snake-friendly and education-oriented "festival" event with a focus on environmental education. This roundup, where, historically, rattlesnakes were ultimately killed (there is one remaining roundup within the range of the eastern indigo snake in Whigham, GA (Adkins 2017)), has changed to a festival where snakes of many species, including eastern indigo snakes, are displayed and information related to snake ecology and conservation is disseminated. Initial efforts to create an eastern indigo snake habitat model for the state of Florida were made by Cox and Kautz (2000). The FWC has built on that effort by creating a revised potential habitat map for this species in Florida based on soil type, habitat fragment size, and other habitat characteristics as well as revising the Florida GAP (Gap Analysis Project) analysis of gopher tortoise habitat, since eastern indigo snakes rely on gopher tortoise burrows when available (Bock and Enge 2014). GDNR has put together a similar habitat model for the eastern indigo snake in Georgia (Elliott 2009). A team of federal, state and other partners led by the Georgia Cooperative Fish and Wildlife Research Unit at the University of Georgia has developed a draft habitat suitability model for gopher tortoises across its range (Crawford and Maerz, 2017, entire). This gopher tortoise suitability map helps to highlight potential areas for eastern indigo snake suitability in the northern portion of its range. The data developed through these projects provide useful information on sites likely to support eastern indigo snake populations. The state of Florida has protected more than 2.4 million ac (1.2 million ha) through its Preservation 2000 and Florida Forever programs (FDEP 2016). In 1998, Florida voters amended the state constitution by ratifying a constitutional amendment that reauthorized bonds for land acquisition. The Florida Forever Act, implemented in 2000, reinforced Florida's commitment to acquire and conserve natural and cultural habitats and better manage these lands. This legislation benefits the recovery of the eastern indigo snake. In section 5.5 of this report we estimate the amount of occupied eastern indigo snake habitat that occurs on protected lands. In 2012, the FWC updated their Gopher Tortoise Management Plan for the state of Florida (FWC 2012). The overarching conservation goal of this management plan is no net loss of gopher tortoises from the time of plan approval in 2012 through 2022. Objectives of the plan include: minimizing the loss of gopher tortoises; increasing and improving gopher tortoise habitat; enhancing and restoring gopher tortoise populations where the species no longer occurs or has been severely depleted on protected, suitable lands; and maintaining the gopher tortoise's function as a keystone species. Eastern indigo snakes in Florida should benefit from these actions taken on behalf of the gopher tortoise. In addition, the plan proposes gopher tortoise burrow commensal conservation actions, which if implemented, would support conservation and recovery of the eastern indigo snake (USFWS, 2019).

- While agricultural lands present some risk to eastern indigo snake populations, negative impacts may be offset by conservation of agricultural lands. For example, conserved agricultural land (e.g. conservation easements, Sustainable Forestry Initiative) may reduce impacts from urbanization, improve wildlife habitat, and maintain connectivity among eastern indigo snake populations.
- In an effort to reduce overall environmental impacts from mining, mitigation and reclamation of mined lands are often implemented. Land protection (mitigation) in strategic areas may help offset impacts to habitat loss; however, effectiveness of reclaiming retired mines and restoring habitat suitability for eastern indigo snakes is not known. (USFWS, 2019)
- The Ocala Conservation Focus Area occurs in portions of Lake, Marion, Putnam, and Volusia counties, Florida. It is situated within portions of Crescent City-Deland Ridge, Lynne Karst, Ocala Scrub, and St. John's Offset Physiographic regions, lies between the Ocklawaha and St. Johns Rivers in central Florida and includes the Ocala National Forest where eastern indigo snakes have been documented in recent surveys (Enge et al. 2013). This Conservation Focus Area includes a significant part of the Big Scrub, a notable ecological area that supports many scrub endemic species. Uplands of approximately 445,997 ac (180,489 ha) of potential eastern indigo snake habitat include oak scrub, sand pine scrub, longleaf pine sandhills, xeric hammocks, and some mesic pine flatwoods. This area supports a very large gopher tortoise population (over 10,000+ individuals) and uplands are actively managed using prescribed fire. Eastern indigo snakes are widespread in this region but do not appear to be especially common. It is not known to what extent the eastern indigo snake depends on gopher tortoise burrows in this area, but it's likely that tortoise burrow use is common where the species overlap. (USFWS, 2021)
- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Protect existing eastern indigo snake populations through appropriate habitat management and conservation techniques identified in site-specific management plans. 2. Protect habitat via land acquisition along corridors of known occupied habitats, such as the river corridors of southeastern Georgia and the central ridge systems of Florida. 3. Work to obtain protection and develop appropriate management plans for sites on privately-owned lands. 4. Study and implement long-term monitoring of eastern indigo snake populations on selected sites across the range of the species. 5. Continue efforts to develop reliable and efficient survey methods. 6. Expand on the initial efforts by Breininger et al. (2004) and Bauder et al. (2018) to determine the appropriate size, acceptable fragmentation level, habitat types, and geographic location for eastern indigo snake reserves across the species' range. 7. Establish a centralized range-wide Geographic Information System (GIS) database for data storage, analyses, and recovery review. 8. Continue reestablishment efforts of the eastern indigo snake in areas where the species has been extirpated. 9. Further develop a range-wide eastern indigo snake habitat

model that incorporates the variety of habitats used by the species throughout its range. 10. Use GIS data to examine landscape level connectivity and habitat quality within the range of the eastern indigo snake. Use these data to prioritize sites for acquisition and habitat management to support recovery of the species. 11. Develop a range-wide conservation action plan that provides appropriate avoidance, minimization and compensation recommendations to reduce impacts to eastern indigo snakes. 12. Continue to survey and monitor for Snake Fungal Disease (Ophidiomyces ophiodiicola), and other pathogens across the range of the eastern indigo snake and research the effects of the disease on populations. 13. Continue to provide public education on the values, attributes, and protected status of the eastern indigo snake. 14. Revise recovery plan and establish measurable recovery criteria. 15. Officially adopt the change in nomenclature of eastern indigo snake to the species Drymarchon couperi. (USFWS< 2019b)

- RECOMMENDED FUTURE ACTIVITIES A detailed discussion of recovery actions and criteria are presented in the Recovery Plan (Service 2019a) and Recovery Implementation Strategy (Service 2019d). In the course of this status review new and/or targeted potential recovery activities were identified and are included below. Recovery Activities • Protect existing eastern indigo snake populations on public lands through appropriate habitat management and conservation techniques identified in site-specific management plans. • Protect habitat via land acquisition along corridors of known occupied habitats, such as the river corridors of southeastern Georgia and the central ridge systems of Florida. • Protect and develop appropriate management plans for sites on privately owned lands. • Continue population reestablishment efforts in areas where the species has been extirpated. • Develop a range-wide conservation action plan that provides appropriate avoidance, minimization, and compensation recommendations to reduce impacts to eastern indigo snakes. • Revise population (conservation) units and Conservation Focus Areas using updated population viability and habitat suitability models. • Continue to engage with the Department of Defense and other partners to implement the Recovery And Sustainment Program (RASP) Initiative in support of eastern indigo snake recovery. Monitoring and Research Activities • Study and implement long term monitoring of eastern indigo snake populations on selected sites across the range of the species. • Continue efforts to develop reliable survey methods. • Complete and apply species-specific population viability model using an updated habitat suitability model (Chandler et al. 2022) and conservation units (Bauder et al. 2022) to reassess populations and their condition range wide. • Expand on the initial efforts by Breininger et al. (2004), Bauder et al. (2018), and others to determine the appropriate size, acceptable fragmentation level, habitat types, and geographic location for eastern indigo snake reserves across the species' range. • Determine measures of success and what constitutes successful population reestablishment. • Study the effects and feasibly of wildlife fencing (permeable and exclusion) on eastern indigo snake populations. • Assess the extent, magnitude, and population effects of ongoing and emerging health and disease issues (e.g., snake fungal disease, C. serpentis, R. orientalis infections, chlorinated pesticides). (USFWS, 2024)

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SPECIES ACCOUNT: *Gopherus agassizii* (Mojave desert tortoise)

Species Taxonomic and Listing Information

Listing Status: Threatened; 8-20-1980 (California/Nevada Region (R8)

Physical Description

The Mojave desert tortoise is a large, herbivorous reptile that occurs north and west of the Colorado River in the Mojave Desert of California, Nevada, Arizona, and southwestern Utah, and in the Sonoran (Colorado) Desert in California. Desert tortoises reach 8 to 15 inches in carapace (upper shell) length and 4 to 6 inches in shell height. Hatchlings emerge from eggs at about 2 inches in length. Adults have a domed carapace and relatively flat, unhinged plastrons (lower shell). Their shells are greenish-tan to dark brown in color with tan scute (horny plate on the shell) centers. Adult desert tortoises weigh 8 to 15 pounds. The forelimbs have heavy, claw-like scales and are flattened for digging; hind limbs are more elephantine.

Taxonomy

The generic assignment of the Mojave desert tortoise has gone through a series of changes since its original description by Cooper (1863) as Xerobates agassizii. It has also been referred to in the literature as Scaptochelys agassizii. The currently accepted scientific name of Gopherus agassizii (Campbell 1988; Crumly 1994) was in use at the time of listing. The Mojave desert tortoise differs from the Sonoran desert tortoise (Gopherus morafkai) in the Sonoran having a relatively narrower shell, shorter gular scutes, shorter projections of the anal scutes and in having a flatter, pear-shaped carapace (Murphy et al. 2011). Note that reliable identification of captive tortoises can be impossible due to hybridization or abnormalities resulting from poor nutrition.

Historical Range

The overall range has not changed very much from historical times, but populations in many areas have substantially declined, though the degree of decline is not well known (USFWS 2010).

Current Range

all tortoises south and east of the Colorado River.

Distinct Population Segments Defined

No.

Critical Habitat Designated

Yes; 8/8/1994.

Legal Description

On February 8, 1994, the U.S. Fish and Wildlife Service (Service) designated critical habitat for the Mojave population of the desert tortoise (Gopherus agassizii), a species federally listed as threatened under the Endangered Species Act of 1973, as amended (Act).

Critical Habitat Designation

Critical habitat for the Mojave desert tortoise is designated in 12 areas, encompassing a total of 8.4 million acres. The Service has designated eight units totaling 4.8 million acres in California, four units totaling 1.2 million acres in Nevada, two units totaling 129,100 acres in Utah, and two units totaling 338,700 acres in Arizona. The final designation encompasses approximately 4,790,500 acres of BLM land, 242,200 acres of military land, 147,200 acres of National Park Service land. 166.200 acres ofState land. 1,600 acres of Tribal land, and 1,098,400 acres of private land.

1. Fremont-Kromer Unit. Kern, Los Angeles, and San Bernardino Counties. From BLM Maps: Victorville 1978 and Cuddeback Lake 1978.

2. Superior-Cronese Unit. San Bernardino County. From BLM Maps: Cuddeback Lake 1978, Soda Mts. 1978, Victorville 1978, and Newberry Springs 1978.

3. Ord-Rodmon Unit. San Bernardino County. From BLM Maps: Newberry Springs 1978 and Victorvllle 1978.

4. Chuckwalla Unit. Imperial and Riverside Counties. From BLM Maps: Chuckwalla #18 1978, Parker-Blythe #16 1978, Salton Sea #20 1978, and Midway Well #21 1979.

5. Pinto Mountain Unit. Riverside and San Bernardino Counties. From BLM Maps: Yucca Valley 1982, Sheep Hole Mountains 1978, Chuckwalla 1978, and Palm Springs #17 1978.

6. Chemehuevi Unit. San Bernardino County. From BLM Maps: Sheep Hole Mts. 1978, Parker 1979, Needles 1978, and Amboy 1991.

7. Ivanpah Unit. San Bernardino County. From BLM Maps: Amboy 1991, lvanpah 1979, and Mesquite Lake 1990.

8. Piute-Eldorado Unit. San Bernardino County. From BLM Maps: Amboy 1991, Needles 1978, and Ivanpah 1979.

9. Piute-Eldorado Unit. Clark County. From BLM Maps: Mesquite Lake 11990, Boulder City 1978. Ivanpah 1979, and Davis Dam 1979.

10. Mormon Mesa Unit. Clark and Lincoln Counties. From BLM Maps: Pahranagat 1978, Clover Mts. 1978, Overton 1978, Indian Springs 1979, Lake Mead 1979, and Las Vegas 1988.

11. Gold Butte-Pakoon Unit. Clark County. From BLM Maps: Overton 1978 and Lake Mead 1979.

12. Beaver Dam Slope Unit. Lincoln County. From BLM Maps: Clover Mountains 1978 and Overton 1978.

13. Beaver Dam Slope Unit. Washington County. From BLM Maps: St. George 1980 andClover Mts. 1978.

14. Upper Virgin River Unit. Washington County. From BLM Map: St. George 1980.

15. BeaverDam Slope Unit. Mohave County. From BLM Maps: Overton 1978 and Littlefield 1987.

16. Gold Butte-Pakoon Unit. Mohave County. From BLM Maps: Overton 1978, Littlefield 1987, Mount Trumbull 1986, and Lake Mead 1979.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements are desert lands that are used or potentially used by the desert tortoise for nesting, sheltering, foraging. dispersal, or gene flow.

Special Management Considerations or Protections

Current and historic desert tortoise habitat loss, deterioration, and fragmentation is largely attributable to urban development, military operations, and multiple-uses of public land, such as off-highway vehicle (OHV) activities and livestock grazing.

Human “predation” (taking desert - tortoises outof their natural populations either by death (accidental or intentional) or by removal) is also a major factor in the decline of the desert tortoise.

Desert tortoises are often struck and killed by vehicles on roads and highways, and mortalityof desert tortoises due to gunshot and OHV activities is common in many parts of the Mojave Region, particularly near cities and towns.

Possible direct impacts from grazing include trampling of both tortoises and shelter sites; possible indirect impacts include loss of plant cover, reduction in number of suitable shelter sites, change in-vegetation. compaction ofsoils, reduced water infiltration, erosion, inhibition-of nitrogen fixation in desert plants, and the provision of a favorable seed-bed far exotic annual vegetation (U.S. Fish and Wildlife Service 1991, 1993).

Common raven (Corvus corax) populations inthe southwestern deserts have increased significantly since the 1940s, presumably in-response to expanding human use of the desert. While not all ravens’may include tortoises as significant components of their diets, these birds are highly opportunistic in their feeding patterns and concentrate on easily available seasonal food sources, such as juvenile tortoises.

Life History

Feeding Narrative

Juvenile: Precipitation is vitally important to the desert tortoise. Summer and winter rain storms provide an immediate source for consumption, as well as stimulating and sustaining the plant forage essential to the survival of the species (Henen et al.1998 p. 370, Duda et al. 1999 p. 1185). Desert tortoise activity increases after rainstorms as they emerge to drink standing water restablishing osmotic homeostasis (Nagy and Medica 1986 p. 79, Henen et al.1998 p. 371, Duda et al. 1999 p. 1182, USFWS 2011 p. 10). Desert tortoises can drink up to 20% of their body mass in water after a rain storm (Nagy and Medica 1986 p. 86). Yearly percipitation rates also influence reproduction. Egg production by female desert tortoises increases during years with wet conditions (Turner et al. 1986 p. 102, Henen et al. 1998 p. 371). While desert tortoises are typically found in areas that receive 5-20 cm or precipitation per year, the species can survive for more than a year without access to free water and can tolerate large imbalances in their water and energy budget (Nagy and Medica 1986 pp. 83-84, Henen et al.1998 p. 371, Duda et al. 1999 p. 1189, USFWS 2011 p. 10).

Adult: Tortoises forage primarily on native winter and summer annuals (dicots and grasses), perennial grasses, cacti, and other vegetation, including a few perennial shrubs. Insects also may be eaten, and caterpillars and other insect larvae may occasionally provide rich lipid and protein supplements to an otherwise vegetarian diet; these may be especially valuable to juvenile growth (Avery, pers. comm.). Annual grasses important in the diet are largely exotic species, part of the Mediterranean "weedland" that dominates spring growth in much of the western Mohave Desert (Berry 1984). Perennial grasses, largely native, contribute more to shelter, soil retention, and a longer growing season. One of the few shrubs regularly ingested is the herbaceous Sphaeralcea ambigua (Berry 1978). Succulent buds, flowers, and fruit are also ingested.

Reproduction Narrative

Adult: Tortoises are long-lived and grow slowly, requiring 13 to 20 years to reach sexual maturity, and have low reproductive rates during a long period of reproductive potential (Turner et al. 1984; Bury 1987; Germano 1994). Growth rates are greater in wet years with higher annual plant production (e.g., desert tortoises grew an average of 12.3 millimeters [0.5 inch] in an El Niño year compared to 1.8 millimeters [0.07 inches] in a drought year in Rock Valley, Nevada; Medica et al. 1975). The number of eggs as well as the number of clutches that a female desert tortoise can produce in a season is dependent on a variety of factors including environment, habitat, availability of forage and drinking water, and physiological condition (Turner et al. 1986, 1987; Henen 1997; McLuckie and Fridell 2002). Mojave desert tortoises lay up to 3 clutches (set of eggs laid at a single time) of eggs per year (Turner et al. 1984, 1986; Henen 1994; Karl 1998; Mueller et al. 1998; Wallis et al. 1999; McLuckie and Fridell 2002). The success rate of clutches has proven difficult to measure, but predation, while highly variable (Bjurlin and Bissonette 2004), appears to play an important role in clutch failure (Germano 1994).

Geographic or Habitat Restraints or Barriers

Adult: The results of human urbanization, such as residential fencing, roads, and railroad tracks, create barriers to movement and population connectivity, leading to inbreeding and mortality; untraversable topography (e.g., cliff); major river, lake, pond, or deep marsh.

Tolerance Ranges/Thresholds

Adult: Desert tortoises retreat into burrows when air temperature reach 91.0° F ± 3.55° F and ground temperatures reach 94.6° F ± 6.05° F; 95 percent of desert tortoise observations of desert tortoises above ground occurred at air temperature less than 91° F (Walde et al. 2003). The body temperature at which desert tortoises become incapacitated ranges from 101.5° F to 113.2° F (Naegle 1976, Zimmerman et al. 1994).

Habitat Narrative

Juvenile: Desert tortoises typically occur in valleys, flats, washes, bajadas, and alluvial fans with sand to sandy-gravel soils at lower elevations and rocky terrain and slopes at higher elevations (USFWS 1994 p. 15, USFWS 2009 p. 3). Home ranges of the desert tortoise can exceed 80 hectares (Berry 1986 p. 118, Duda et al. 1999 p. 1181, USFWS 2011 p. 10). Core areas within the larger home range is comprised of a network of burrows in which the desert tortoise spends most of its life (Nagy and Medica 1986 p. 78, Duda et al. 1999 p. 1187, Harless et al. 2009 p. 378, USFWS 2011 p. 10). Burrows are used by the species for predator avoidance, thermoregulation, and reproduction (Duda et al. 1999 p. 1181, Harless et al. 2009 p. 378). Burrows may be excavations into the soil, shallow scrapes under vegetation, or naturally occuring caliche caves, rock crevices or overhangs (USFWS 2009 p. 3, USFWS 2011 p. 11). The species requires soils that are friable enough to burrow into but firm enough not to collapse (USFWS 2011 p. vii). Desert tortoises avoid thermal extremes by taking shelter in burrows during the hottest part of the day and by hibernating in burrows during low winter temperatures (Duda et al. 1999 p. 1182). Desert tortoises retreat into burrows when air temperature reach 91.0° F ± 3.55° F and ground temperatures reach 94.6° F ± 6.05° F; 95 percent of desert tortoise observations of desert tortoises above ground occurred at air temperature less than 91° F (Walde et al 2003). The body temperature at which desert tortoises become incapacitated ranges from 101.5° F to 113.2° F (Naegle 1976, Zimmerman et al. 1994). While inactive in burrows, desert tortoises loose extremely little water or energy while avoiding extreme temperatures (Duda et al. 1999 p. 1189). Burrows are also used for the deposition of eggs and for courtship behavior during nesting (Turner et al.1986 p. 95, Berry 1986 pp. 116-117).

Adult: Optimal habitat for the Mojave desert tortoise has been characterized as creosote bush scrub in which precipitation ranges from 2 to 8 inches, where a diversity of perennial plants is relatively high, and production of ephemerals is high (Luckenbach 1982, Turner 1982, Turner and Brown 1982). Soils must be friable enough for digging burrows, but firm enough so that burrows do not collapse. Desert tortoises occur from below sea level to an elevation of 7,300 feet, but the most favorable habitat occurs at elevations of approximately 1,000 to 3,000 feet (Luckenbach 1982). They are most commonly found within the desert scrub vegetation type, primarily in creosote bush scrub. In addition, they occur in succulent scrub, cheesebush scrub, blackbrush scrub, hopsage scrub, shadscale scrub, microphyll woodland, Mojave saltbush-allscale scrub and scrub-steppe vegetation types of the desert and semidesert grassland complex (Service 1994). Within these vegetation types, Mojave desert tortoises potentially can survive and reproduce where their basic habitat requirements are met. These requirements include a sufficient amount and quality of forage species; shelter sites for protection from predators and environmental extremes; suitable substrates for burrowing (see below), nesting, and overwintering; various plants for shelter; and adequate area for movement, dispersal, and gene flow. The results of human urbanization, such as residential fencing, roads, and railroad tracks, create barriers to movement and population connectivity, leading to inbreeding and mortality.Throughout most of the Mojave Region, tortoises occur most commonly on gently sloping terrain with soils ranging from sandy-gravel and with scattered shrubs, and where there is abundant inter-shrub space for growth of herbaceous plants. Throughout their range, however, tortoises can be found in steeper, rockier areas (Gardner and Brodie 2000).

Dispersal/Migration

Migratory vs Non-migratory vs Seasonal Movements

Adult: Local migrant moving relatively short distances from winter burrows to summer feeding grounds.

Dispersal

Adult: Establish home range

Dependency on Other Individuals or Species for Dispersal

Adult: Burrows created by other species

Dispersal/Migration Narrative

Adult: The size of desert tortoise home ranges varies with respect to location and year (Berry 1986a) and also serves as an indicator of resource availability and opportunity for reproduction and social interactions (O'Connor et al. 1994). Females have long-term home ranges that may be as little or less than half that of the average male, which can range to 80 or more hectares (200 acres) (Burge 1977; Berry 1986a; Duda et al. 1999; Harless et al. 2009). Core areas used within tortoises' larger home ranges depend on the number of burrows used within those areas (Harless et al. 2009). Over its lifetime, each desert tortoise may use more than 3.9 square kilometers (1.5 square miles) of habitat and may make periodic forays of more than 11 kilometers (7 miles) at a time (Berry 1986a). During periods of drought, desert tortoises decrease surface activity and remain mostly inactive or dormant underground (Duda et al. 1999), which reduces water loss and minimizes energy expenditures (Nagy and Medica 1986). Duda et al. (1999) showed that home range size, number of different burrows used, average distances traveled per day, and levels of surface activity were significantly reduced during drought years.

Population Information and Trends

Population Trends:

Declining

Species Trends:

Declining

Population Growth Rate:

Declining

Number of Populations:

Unknown

Population Size:

~212,343 (USFWS, 2022)

Resistance to Disease:

Moderate

Adaptability:

Low

Population Narrative:

Populations of Majove desert tortoise are typically uneven in density and often discontinuously distributed. This is particularly true of the upland "island" populations (Dodd 1982). Even in relatively undisturbed expanses of good lowland Mojave Desert habitat high density clusters are separated by low densities or even total absence. The minimal population unit, or deme, could be as small as 10-20 adults. Intervening habitat supporting less than 10 adult tortoises/sq mi could effectively isolate, at least behaviorally, such patches. Such patches, estimated by the collective home ranges, and allowing for partial overlap, might cover 500-1,000 hectares. Larger demographic units could be defined in terms of clusters of these demes isolated by topographic barriers, namely uplands higher than 4,000 to 5,200 feet (Yucca Mt., Nevada) in the Mojave Desert and paradoxically, valleys below 2,000 feet elevation in the Sonoran Desert. [This paragraph by D. Morafka.] Adult Mojave desert tortoise populations surveyed from 2001 to 2013 in the Northeastern Mojave Recovery Unit increased by almost 20% per year since 2004, with the rate of increase apparently resulting from increased survival of adults and sub-adult tortoises moving into the adult size class. Populations surveyed in the other four recovery units are declining: Upper Virgin River (-5.1%), Western Mojave (-9.8%), and Colorado Desert (-2.4%, however, two of the Tortoise Conservation Areas appear to be increasing). Overall, we are seeing fewer juvenile tortoises in all recovery units except a slight increase in Eastern Mojave. Of particular concern is a large decline in the proportion of juveniles found in the Western Mojave, where there has been a serious drop in the number of adults. This trend indicates that juveniles show an even more stark decrease than the adults, and that we do not see recovery of the number of adults in the near future, given this decline in number of juveniles. (L. Allison, pers. comm. 2014). Populations are declining. 2014 estimates 212,343 total (USFWS, 2022).

Threats and Stressors

Stressor: Habitat loss, fragmentation, and degradation
Exposure:
Response:
Consequence:
Narrative: Since the 1800s, portions of the desert southwest occupied by desert tortoises have been subject to a variety of impacts that cause habitat loss, fragmentation, and degradation, thereby threatening the long-term survival of the species (USFWS 1994a). Some of the most apparent threats are those that result in mortality and permanent habitat loss across large areas, such as urbanization, and those that fragment and degrade habitats, such as proliferation of roads and highways, off-highway vehicle activity, poor grazing management, and habitat invasion by nonnative invasive species (Berry et al. 1996; Avery 1997; Jennings 1997; Boarman 2002; Boarman and Sazaki 2006). Indirect impacts to desert tortoise populations and habitat are also known to occur in areas that interface with intense human activity (Berry and Burge 1984; Berry and Nicholson 1984b).

Stressor: Non-native invasive species
Exposure:
Response:
Consequence:
Narrative: A threat that has come to the forefront is the invasion of desert habitats by non-native plant species and the resultant increased frequency of wildfire (USFWS 1994a; Brooks 1998). Changes in plant communities caused by non-native plants and recurrent fire can negatively affect the desert tortoise by altering habitat structure and species available as food plants (Brooks and Esque 2002). Off-highway vehicle activity, roads, livestock grazing, agricultural uses, and other activities contribute to the spread of non-native species (or the displacement of native species) and the direct loss and degradation of habitats (Brooks 1995; Avery 1998). For example, unmanaged livestock grazing, especially where plants are not adapted to large herbivorous mammals or where the non-native species are less palatable than the natives, can preferentially remove native vegetation, leaving non-native plants to grow under reduced competition (Wittenberg and Cock 2005:228).

Stressor: Energy development
Exposure:
Response:
Consequence:
Narrative: Dozens of project sites have been proposed for the development of solar and wind energy development on public lands within the range of the desert tortoise in California and Nevada. The Bureau of Land Management has committed to excluding these projects from designated critical habitat for the desert tortoise and Desert Wildlife Management Areas. However, potential long-term effects of large-scale energy development fragmenting or isolating desert tortoise conservation areas and cutting off gene flow between these areas have not been evaluated.

Stressor: Negative effects of human settlements (e.g., landfills, toxic chemicals, increased predators, etc.)
Exposure:
Response:
Consequence:
Narrative: Landfills and other waste disposal facilities potentially affect desert tortoises and their habitat through fragmentation and permanent loss of habitat, spread of garbage, introduction of toxic chemicals, increased road kill of tortoises on access roads, and increased predator populations (Boarman et al. 1995; Kristan and Boarman 2003). Military operations (e.g., construction and operation of bases, field maneuvers) have taken place in the Mojave Desert since 1859 and can affect tortoises and their habitats similarly to other large human settlements (i.e., illegal collection of tortoises, trash dumping, increased raven (Corvus corax) populations, domestic predators, off-highway vehicle use, increased exposure to disease, and increased mortality) (USFWS 1994a; Krzysik 1998; Boarman 2002).

Stressor: Disease
Exposure:
Response:
Consequence:
Narrative: To date the available evidence indicates that upper respiratory tract disease, as caused by the bacteria Mycoplasma agassizii and M. testudineum (Jacobson et al. 1991), is probably the most important infectious disease affecting desert tortoises. Less is known about other diseases that have been identified in the desert tortoise (e.g., herpesvirus, cutaneous dyskeratosis, shell necrosis, bacterial and fungal infections, and urolithiasis or bladder stones) (Jacobson et al. 1994; To date the available evidence indicates that upper respiratory tract disease, as caused by the bacteria Mycoplasma agassizii and M. testudineum (Jacobson et al. 1991), is probably the most important infectious disease affecting desert tortoises. Less is known about other diseases that have been identified in the desert tortoise (e.g., herpesvirus, cutaneous dyskeratosis, shell necrosis, bacterial and fungal infections, and urolithiasis or bladder stones) (Jacobson et al. 1994; Homer et al. 1998; Berry et al. 2002b; Origgi et al. 2002). There is evidence that any one disease may predispose an animal to other diseases (Christopher et al. 2003). However, it is not known whether this is a cause or effect. Additional research is needed to clarify the role of disease in desert tortoise population dynamics relative to other threats.

Stressor: Global climate change and drought

Exposure: See narrative.
Response: See narrative.
Consequence: See narrative.
Narrative: Global climate change and drought are potentially important long-term considerations with respect to recovery of the desert tortoise. There is now sufficient evidence that recent climatic changes have affected a broad range of organisms with diverse geographical distributions (Walther et al. 2002). While little is known regarding specific direct effects of climate change on the desert tortoise or its habitat, predictions can be made about how global and regional precipitation regimes may be altered and about the consequences of these changes (Weltzin et al. 2003; Seager et al. 2007).

Recovery

Reclassification Criteria:
Not applicable.

Recovery Priority Number: 11C

Delisting Criteria:
Rates of population change (?) for desert tortoises are increasing (i.e., ? > 1) over at least 25 years (a single tortoise generation), as measured: (a) by extensive, range-wide monitoring across tortoise conservation areas within each recovery unit, and (b) by direct monitoring and estimation of vital rates (recruitment, survival) from demographic study areas within each recovery unit.

Distribution of desert tortoises throughout each tortoise conservation area is increasing over at least 25 years (i.e., ? [occupancy] > 0).

The quantity of desert tortoise habitat within each desert tortoise conservation area is maintained with no net loss until tortoise population viability is ensured. When parameters relating habitat quality to tortoise populations are defined and a mechanism to track these parameters established, the condition of degraded desert tortoise habitat should also be demonstrably improving.

Recovery Actions:
- Develop, support, and build partnerships to facilitate recovery through prioritization, coordination, and implementation of recovery plan.
- Protect existing populations and habitat.
- Augment depleted populations through a strategic program.
- Monitor progress toward recovery.
- Conduct applied research and modeling in support of recovery efforts within a strategic framework.
- Implement an adaptive management program.

Conservation Measures and Best Management Practices:
- RECOMMENDATIONS FOR FUTURE ACTIONS In light of declining trends across much of the Mojave Desert Tortoise's range and the status of threats across the range, the highest-priority actions over

the next five years are listed below. Recommended actions in the 2011 recovery plan are identified by recovery action number. 1. Most importantly, the top recovery actions endorsed by the Desert Tortoise MOG require more aggressive implementation (Fig. 5). a. Habitat restoration (Recovery Action 2.6): Define habitat status and desired conditions relative to desert tortoise fitness (5.1 and 5.2, in part) and target restoration or protection efforts to meet those conditions. Habitat restoration should address invasive weeds, native forage plants, and recovery of unpaved roads and routes. b. Minimize excessive predation on tortoises by decreasing predator access to human subsidies and with targeted predator control (2.14). Demographic models should guide efforts to reduce raven abundance and predation rates on tortoises via tools such as oiling raven eggs to prevent hatching as well as efforts to remove targeted numbers of breeding and non-breeding adults in areas that exceed 0.89 ravens/km2 or other thresholds derived from updated modeling. All active raven nests within approximately 1–2 km, depending on local raven density, of TCAs should be oiled or removed. c. Install and maintain tortoise barrier fencing (2.5, in part) along priority stretches of highways (see Holcomb 2019). d. Fire management planning and implementation (2.1, in part): Fire prevention and management should be pursued throughout the Mojave and Colorado deserts to contain the grass-fire cycle. Minimizing the size and intensity of fires will ease subsequent restoration efforts, even in previously burned areas. Identifying and mapping priority areas and developing a fire plan for habitat protection, fire-crew access, and the use of natural or created fuel breaks could help limit response time and fire spread. e. Environmental education (2.3): Coordinated, consistent messaging should increase awareness on how targeted user groups, such as off-highway-vehicle enthusiasts, and the general public can recreate responsibly to minimize their impacts on desert tortoise populations and should include subjects such as adoption programs for captive tortoises, the importance of discouraging unauthorized breeding of desert tortoises in captivity, and the illegality of releasing captive tortoises into wildlands. 2. Maintain landscape connectivity and the resilience of TCAs (2.11) via actions described by Averill-Murray et al. (2021). a. Manage all desert tortoise habitat for persistence and connectivity. For example, managing the entire remaining matrix of desert tortoise habitat outside TCAs for permeability may be better than delineating fixed corridors between TCAs. b. Limit landscape-level disturbance across habitat managed for the desert tortoise (2.1) by extending surface-disturbance caps similar to those enacted by the DRECP in California to the rest of the Mojave Desert Tortoise's range. c. In addition to minimizing mortality from roads as per 1.c, above, maximize passage under roads, e.g., by filling eroded drop-offs or by modifying erosion-control features such as rip-rap at culvert entrances to make them safer and more passable for tortoises. d. Adapt management based on information from research (5.5) on i) the effects of climate change on desert tortoise habitat, distribution, and population connectivity; ii) the effects of large-scale fires, especially within repeatedly burned habitat, on desert tortoise distribution and population connectivity; iii) the ability of solar energy facilities or similar developments to support tortoise movement and presence by leaving washes and native vegetation intact; and iv) the design and frequency of underpasses necessary to maintain functional demographic and genetic connectivity across roads and highways. 3. Increase law enforcement efforts across the range of the desert tortoise (2.4), especially within TCAs, to minimize impacts of habitat destruction and degradation as a result of unauthorized OHV use, unpermitted cannabis farms, and trespass grazing. 4. Use population augmentation to help achieve recovery criteria in each of the five recovery units according to the Fish and Wildlife Service's population augmentation strategy (3.2– 3.4). Individual augmentation plans should include design, feasibility and risk assessment, implementation, monitoring, and evaluation and adjustment elements (Service 2021d). 5. Update the taxonomy, distribution, and listed status of Gopherus agassizii under the Endangered Species Act to include populations east of the Colorado River (Fig. 1). A "similarity of appearance" rule may be necessary for G. morafkai populations or individuals that occur within the range of the Mojave Desert Tortoise. 6. Incorporate updated population trend analysis (Service, in progress) and climate change/landuse modeling (5.5: Heaton 2020; Shoemaker 2020) into the next 5-year review. These climate-change models should be used to inform management strategies under the ResistAccept-Direct framework for ecological adaptation (Schuurman et al. 2021; Williams 2021). 7. Range-wide monitoring efforts continue to fluctuate at suboptimal levels due to inconsistent funding (Allison and McLuckie 2018). Therefore, we reiterate the 2002 recommendation “that the Secretary of the Interior work with the Secretary of Defense and other agencies and organizations involved in tortoise recovery to identify and assess options for securing continued funding for rangewide population monitoring” to ensure that long-term monitoring of the desert tortoise is sustained (General Accounting Office [GAO] 2002). Estimation of trends within TCAs also would be improved by streamlining individual-agency access processes. For example, access has been difficult to obtain for certain parcels of critical habitat during the primary tortoise active season. 8. Develop a revised spatial decision support system to improve models of threats, recovery actions, and tortoise demographics (5.3, 6.1). Development should include up-to-date underlying geospatial data, evaluation of prior conceptual models, and improved operationalization of recovery action terminology (USFWS, 2022)

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SPECIES ACCOUNT: *Gopherus polyphemus* (Gopher tortoise)

Species Taxonomic and Listing Information

Listing Status: Threatened; Southeast Region (R4); Candidate; Southeast Region (R4) (USFWS, 2015)

Physical Description

Gopher tortoise, Testudinidae.The gopher tortoise is a relatively large (carapace length often 15-28 cm, but up to 38 cm) terrestrial turtle with a domed carapace, short elephantine hindlimbs, shovellike forelimbs, a gular projection from the anterior plastron, and a short tail. The anterior surface of the flattened forelimb is covered with 7-8 rows of large scales. Often the surface of the carapace is quite smooth in adults, reflecting the abrasion it receives as an individual enters or exits its burrow. The carapace is keelless and oblong, with the greatest width just anterior to the well-developed bridge (connecting the carapace to the plastron), and the greatest height in the sacral region. The carapace drops off abruptly to the rear of the highest region (Ernst and Barbour 1972). The carapace of an adult varies from dark- brown to grayish-black. In Florida, individuals from coastal areas are generally darker than those from central populations. The gular scutes of the robust, hingeless plastron project below the chin. Males often have longer gular projections than do females. However, because both sexes use their projections during agonistic encounters, the gular projections are often broken and may not be an accurate diagnostic feature of the sex of an individual (Mushinsky et al. 1994). Most gopher tortoises have well defined "growth rings" on the scutes of the yellowish plastron. Use of the growth rings to age individuals must be done with caution, as there is much variation in the number of "false" growth rings throughout the range of this taxon. Female gopher tortoises become sexually mature at a carapace length of about 23-24 cm. Males are somewhat smaller at maturity and do not obtain the large body size of females. The best indicator of the sex of an adult gopher tortoise is the depth of the plastral concavity (Mushinsky et al. 1994). Mature males have a shallow depression in the posterior, central portion of the plastron to facilitate mounting a female for copulation. Large females may have a shallow plastral concavity (2-4 mm) compared to the deeper concavity found on mature males (5-8 mm). Males often have larger integumentary glands under the chin than do females (Ernst and Barbour 1989), but the size of these integumentary glands varies seasonally. Based upon numerous anatomical measurements, McRae et al. (1981a) developed a discriminant function that accurately identified the sex of adult individuals. Using a stepwise multiple regression on numerous morphological measurements, Burke et al. (1994) developed a non-invasive sex identification technique for determining the sex of hatchling and juvenile gopher tortoises. Hatchlings emerge from their eggs at a carapace length of generally about 3-5 cm. Coloration of the vertebral and costal scutes of the carapace of hatchlings is yellowish to yellowish-orange, and each scute is bordered by brownish coloration (Allen and Neill 1953). The skin on the head and limbs is likewise brightly colored yellow to yellowish-orange. The bright coloration of hatchlings darkens during the first year or two of life. The gular scutes of young tortoises do not project forward as in the adult tortoises, and the claws of young tortoises are long and sharp (Allen and Neill 1953). Hatchlings dig their own burrows, often just a few meters away from the nest from which they emerged. Hatchlings and juveniles, up to an age of 5-7 years, have relatively soft shells and are highly vulnerable to predation (Wilson 1991). Eggs are white, nearly spherical, and brittle-shelled. For photographs of eggs see Allen and Neil (1951) and Pope (1939). Iverson (1980) reported an average maximum egg diameter of 42-43 mm and an average wet mass of 40.9 g (also see Arata 1958, Landers et al. 1980). LENGTH:28 (NatureServe, 2015)

Taxonomy

Auffenberg (1976), Bramble (1982), Crumly (1987, 1994), and Lamb and Lydeard (1994) provided information on phylogenetic relationships among tortoises of the genus Gopherus, which comprises four living species and nine fossil taxa. A recent study of phylogeny based on mtDNA variation identified the four living North American tortoises as a monophyletic group consisting of two well-defined clades, the agassizii clade and the polyphemus clade (Lamb and Lydeard 1994). MtDNA and osteological data indicate that G. polyphemus is more closely related to G. flavomarginatus of Mexico than it is to the other two species of Gopherus. Gopherus polyphemus is only slightly distinct from G. flavomarginatus based on allozymes (Morafka et al. 1994). Using mtDNA, Osentoski (1993) assessed rangewide genetic variation and found three major assemblages: (1) a western assemblage consisting of seven haplotypes (Louisiana eastward to Taylor County, Florida, and along the Chattahoochee River drainage north to Talbot County, Georgia); (2) an eastern assemblage containing the two most common haplotypes (South Carolina through peninsular Florida) and (3) a mid-Florida assemblage consisting of seven haplotypes (along the Gulf coast from southern Levy County north to Pinellas County, then east to north of the Hillsborough River, and northeast into Orange/Oseola counties). (NatureServe, 2015)

Historical Range

Southeastern United States from southern South Carolina (Clark et al. 2001) through southern Georgia to southern Florida (excluding most of inland southern Florida), west through southern Alabama and southeastern Mississippi to eastern Louisiana (Diemer 1989). Occurs on islands off the Gulf coast of Florida as far south as Cape Sable (Logan 1981, Kushlan and Mazzotti 1984, Mushinsky and McCoy 1994). Most common in southern Georgia and northern and central Florida (Diemer 1989). (NatureServe, 2015)

Current Range

At the northern end of the range in South Carolina, four disjunct populations remain in Jasper County and a few tortoises occur in southern Hampton County (Wright 1982); recently found in Aiken County (Clark et al. 2001). In Georgia, large populations occur in the western Fall Line Sand Hills and the central Tifton Uplands (Landers and Garner 1981); severely fragmented populations occur in the Coastal Plain. The largest remaining population in Mississippi is in Desoto National Forest (Lohoefener and Lohmeier 1984). A few populations remain at the western edge of the range in eastern Louisiana. For a detailed range map, see Iverson (1992). (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Feeding Narrative

Adult: The gopher tortoise is the primary grazer in its xeric habitats (Landers 1980) and aids in seed dispersal for native grasses (Auffenberg 1966) (USFWS, 1990). Females normally reach sexual maturity at 19-21 years of age and males reach sexual maturity at a younger age than females (USFWS, 1990).

Reproduction Narrative

Adult: Longevity is estimated at 40-60 years (Landers 1980) and may extend to 80—100 years (Landers et al. 1982). Growth annuli on scutes become worn at 20—40 years, making age determination imprecise. Age at sexual maturity in the Georgia study (Landers et al. 1982) ranged from 19-21 years for females. These animals had a plastral length of 25—26.5 cm (9.8—10.4 inches). Males normally reach reproductive maturity at a smaller size and younger age than females. Growth rates vary with environmental and genetic factors among gopher tortoise populations. Breeding periods may begin as early as February and extend into September, depending on location. The period of maximum reproductive activity reported by Landers et al. (1980) is May 18 through June 27. Iverson (1980) reported the nesting peak in Florida also to be May and June. Clutch sizes in Mississippi average 4.8 eggs (Lohoefener and Lohmeier 1984); however, this report was based on a rather small sample (N=14). Landers et ~ (1980) reported a range in clutch size of 4-12 eggs with a mean and SD of 7.0 + 1.7. He also found that clutch size increased with the size of the female. The lower value reported by Lohoefener and Lohmeier (1984) may have been due to limited sampling, the result of human depredation (leaving primarily smaller nesting females), or a combination of both. The nest is usually 15—25 cm (6—10 inches) beneath the surface (Landers et al. 1980). Incubation periods range from 80-90 days in northern Florida (Iverson 1980) to 110 days in South Carolina, the northern limit of the gopher tortoise's range (Wright 1982). Most gopher tortoise eggs never hatch because of predation (USFWS, 1990).

Tolerance Ranges/Thresholds

Adult: Moderate (inferred based on USFWS, 1990)

Site Fidelity

Adult: Moderate (inferred based on USFWS, 1990)

Habitat Narrative

Adult: Gopher tortoises occupy a wide range of upland habitat types; however, general physical and biotic features provided by Landers (1980) with slight modifications, characterize most suitable habitat. These are: 1. the presence of well-drained, sandy soils, which allow easy burrowing (because of lower ambient temperatures, the western population may require a meter or more of sandy soil depths); 2. an abundance of herbaceous ground cover; and 3. a generally open canopy and sparse shrub cover, which allow sunlight to reach the forest floor. Juvenile habitat is generally considered to be similar to that of adults. The traditional habitats of the western population of gopher tortoises are natural xeric communities, mostly of the longleaf-pine-scrub oak type, located on sand ridges. The original ecology of these xeric, fire—dependent communities has been significantly altered. Gopher tortoises may also be found in ruderal habitats such as fence rows, pastures, and field edges and power lines (USFWS, 1990). Moderate ecological integrity of the population, tolerance ranges and site fideilty are inferred based on the species ability to survive in degraded environments and tolerate less than ideal habitats for atelast a moderate amount of time.

Dispersal/Migration

Motility/Mobility

Adult: low (USFWS, 1990)

Migratory vs Non-migratory vs Seasonal Movements

Adult: Non-migratory (USFWS, 1990)

Dispersal/Migration Narrative

Adult: McRae et al. (1981) studied movement related to feeding separately from movements related to other behavior and determined 95 percent of all feeding activity took place within 30 m (33 yards) of the burrow being used. Auffenberg and Iverson (1979) reported increasing foraging radii from the burrow in areas with reduced ground cover. This suggests that food availability can increase or decrease foraging distances. McRae et al. (1981) trailed 13 adults and determined their movements to be in a nearly circular or elliptical pattern around the burrow. Depletion of preferred foods near burrows by late summer is thought to contribute to larger movements later in the year. In the Georgia study, the home ranges of =aleswere much larger than females; males had a home x=ngeof~ 0.06—1.44 ha (0.14—3.56 A) with a mean of 0.47 ha (1.16 A), while females had a home range of 0.04-0.14 ha (0.10—0.35 A) with a. mean of 0.08 ha (0.20 A) (McRae et al. 1981). The sexual differences are attributed to breeding forays by the males. Landers and Speake (1980) found the average colony typically used an area less than 4 ha (9.88 A) (USFWS, 1990).

Population Information and Trends

Number of Populations:

656 (USFWS, 2021)

Population Size:

~ 149,152 (USFWS, 2021)

Population Narrative:

Currently, there are an estimated 149,152 gopher tortoises from 656 spatially delineated local populations across the range of the species, with local abundance categories as follow: 360 low, 169 moderate, and 127 high (USFWS, 2021).

Threats and Stressors

Stressor: Habitat alteration (USFWS, 1990)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The current threats to the western population of the gopher tortoise in terms of habitat loss or degradation consist of certain forest management practices, conversion of dry sites to agriculture, road placement and other developments on these higher ridges, and urbanization (Lohoefener and Lohmeier 1984) (USFWS, 1990).

Stressor: Predation (USFWS, 1990)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Gopher tortoise predators, other than -human beings, are many. The most important egg and hatchling predator appears to be the raccoon (Procyon lotor) (Landers and Speake 1980);

however, a variety of mammals are reported predators of G. polyphemus, including gray foxes (Urocvon cinereoarcrenteus), striped skunks (Mephitis mephitis) , opossums (Didelphis vir~iniana), armadillos (Dasvnus noveincinctus) (Landers et al. 1980), and dogs (Canis domesticus) (Causey and Cude 1978). Imported fire ants (Solenopsis saevissima and/or ~. victa) are reported as hatchling predators (Landers et al. 1980, Lohoefener and Lohmeier 1984). Snakes and raptors have also been reported as preying on G. polyphemus. Reported clutch and hatchling losses often approach 90 percent (Landers et al. 1980) (USFWS, 1990).

Stressor: Other mortality (USFWS, 1990)
Exposure:
Response:
Consequence: Loss of indiivduals
Narrative: Road mortality is reported by Landers and Buckner (1981) and Lohoefener and Lohmeier (1984) as a significant mortality factor. Lohoefener and Lohmeier (1984) believe nests and juveniles are often destroyed by intensive site preparation (heavy equipment). Tanner and Terry (1981) report a major reduction in burrow density in Florida which was believed attributable to roller chopping or web plowing. Diemer and Moler (1982) demonstrated that tortoises are able to dig out following chopping treatment on deep sandy soils, but concluded that additional data were needed regarding tortoise response to various site preparation techniques in different soil types. Lohoefener and Lohmeier (1981) believed that a serious problem for the Mississippi goph9rtortoise was isolation of sexually mature animals becaus&of habitat fragmentation aggravated by forest management practices. Only 14 percent of the tortoises encountered in density survey transects by Lohoefener and Lohmeier (1981) in Mississippi were considered so situated that interactions with other sizeable (sexually mature) tortoises might occur. As further support for this hypothesis, the discontinuous nature and small size of Mississippi sand ridges, which are often separated by streams or wet boggy areas, may serve as impediments to courtship travels of adult males (Lohoefener and Lohmeier 1984) (USFWS, 1990).

Stressor: Population Viability (USFWS, 1990)
Exposure:
Response:
Consequence: Localized extinction
Narrative: Local populations of the western gopher tortoise can in theory become extirpated through chance events and these extirpations (and thus more rangewide extirpations) are inversely related to population size. Shaffer (1981) cites four sources of uncertainty to which a population may be subject: (1) demographic stochasticity, which arises from chance events in the survival and reproductive success of a finite number of individuals; (2) environmental stochasticity due to temporal variation of habitat parameters and the populations of competitors, predators, parasites, and diseases; (3) natural catastrophes, such as floods, fires, and droughts, which may occur at random intervals through time; and (4) genetic stochasticity resulting from changes in genetic frequencies due to founder effect, random fixation, or inbreeding. Based on the concern expressed by Lohoefener and Lohmeier (1984) regarding reproductive isolation, genetic drift and inbreeding may already be occurring. Recovery, therefore, must consider population viability in establishing both the objectives and the procedures for meeting those objectives (USFWS, 1990).

Recovery

Reclassification Criteria:
Recovery Priority Number: 9

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SPECIES ACCOUNT: *Masticophis lateralis euryxanthus* (Alameda whipsnake (=striped racer))

Species Taxonomic and Listing Information

Commonly-used Acronym: None

Listing Status: Threatened; December 5, 1997 (62 FR 64306).

Physical Description

The Alameda whipsnake (Masticophis [=Coluber] lateralis euryxanthus) is a slender, fast-moving, diurnal snake with a broad head, large eyes, and slender neck (USFWS 2011). Adults reach a length of 91 to 122 centimeters (3 to 4 feet [ft.]) (USFWS 2005). Their back is colored sooty black or dark brown, and has a distinct yellow-orange stripe down each side. The front part of their underside is orange-rufous colored. The midsection is cream colored. The rear section and tail are pinkish. This subspecies is distinguished by eight morphological identifiers: 1. A broad dorsolateral light stripe, one and two half-scales wide, or occasionally two full scales wide, on the anterior two-thirds of the body. 2. A virtual lack of black spotting on the ventral surface of the head and neck. 3. A light stripe between nostril and eye usually not interrupted by dark vertical lines along the margins of the loreal. 4. The lack, usually, of a dark line across the rostral, representing a connection between the supralabial stripes. 5. Direct communication anteriorly between lateral light stripe and the light venter. 6. The absence of dorsal color on the ventrals for a distance back from the snout equal to four and one-half to six times the distance from the posterior edge of the parietals. 7. A sooty black dorsal color. 8. The presence of life of a heavy suffusion of orange-rufous on the anterior light portions of the body (Riemer 1954; USFWS 2002).

Taxonomy

Two subspecies of the California whipsnake (Masticophis lateralis) are recognized: Alameda whipsnake (M. l. euryxanthus) and chaparral whipsnake (M. l. lateralis). There are no definitive geographic boundaries that separate the Alameda whipsnake phenotype from the chaparral whipsnake phenotype. Rather, there appears to be a transition zone in southern and eastern Alameda, northern Santa Clara, and southwestern San Joaquin counties. The zone of intergradation occurs where the two species co-occur and breed, producing individuals with characteristics that reflect, to varying degrees, both parents. Some characteristics of the species are more variable than others. Maps are being developed that depict the geographic distribution of each of the eight phenotypic characters, describe the observed variation in each of the eight characters, and present evidence of characters changing over time in individual snakes. There have been no taxonomic classification or nomenclature changes to the species since its listing. Recent mtDNA phylogenetic results provide evidence that the evolutionary history of the Alameda whipsnake is not distinct from other California whipsnakes throughout the central California clade (USFWS 2003; USFWS 2011). None of the eight morphological differences used by Riemer (Riemer 1954) to describe the Alameda whipsnake are diagnostic; that is, each of the eight morphological characters used to describe Alameda whipsnake as a subspecies have been observed in chaparral whipsnake specimens far removed from the San Francisco East Bay. Interpreting some of the eight characters is ambiguous; for instance, distinguishing characteristic number three in Riemer (1954) is described as, “A light stripe between nostril and eye usually not interrupted by dark vertical lines along the margins of the loreal"; characteristic number four is described as, "The lack, usually, of a dark line across the rostral, representing a connection between the supralabial stripes"; and characteristic number seven is described as, "A sooty black dorsal color." Melanistic individuals are, however, not uncommon throughout the range of the species. Throughout much of Alameda and Contra Costa counties, Alameda whipsnake specimens exhibit five or more of the eight characters, particularly in the East Bay Hills (USFWS 2011).

Historical Range

The Alameda whipsnake inhabits the inner Coast Ranges in western and central Contra Costa and Alameda counties. The historical range was continuous, but has been fragmented into five disjunct populations: Tilden–Briones, Oakland–Las Trampas, Hayward–Pleasanton Ridge, Sunol–Cedar Mountain, and Mount Diablo–Black Hills (62 FR 64306).

Current Range

The range of the Alameda whipsnake and phenotypic-intergrade specimens includes mosaics of chaparral, coastal scrub, and adjacent vegetation types throughout Contra Costa County, most of Alameda County, and small portions of northern Santa Clara and western San Joaquin counties. This range can be subdivided into five populations that correspond to relatively contiguous mosaics of suitable habitat types that are fragmented by urban development, transportation corridors, and a lack of coastal scrub and chaparral vegetation in the Tri-Valley. Alameda whipsnakes have been found to be locally abundant, and are the dominant snake species when habitat quality is high (USFWS 2011).

Distinct Population Segments Defined

No

Critical Habitat Designated

Yes; 10/3/2000.

Legal Description

On October 2, 2006, the U.S. Fish and Wildlife Service designated critical habitat for the Alameda whipsnake (Masticophis lateralis euryxanthus) pursuant to the Endangered Species Act of 1973, as amended (Act). Six critical habitat units were designated in Alameda, Contra Costa, Santa Clara, and San Joaquin Counties, California. An earlier Final Rule designating critical habitat, published on October 3, 2000 (65 FR 58933 - 58962), was vacated in 2003 by a U.S. District Court.

Critical Habitat Designation

Seven critical habitat units (1, 2, 3, 4, 5, 5B, and 6) are designated as as critical habitat for the Alameda whipsnake, encompassing approximately 154,834 acres (ac) (62,659 hectares (ha)).

Unit 1: Tilden-Briones; Alameda and Contra Costa Counties (34,119 ac (13,808 ha)). Unit 1 is bordered approximately by State Highway 4 and the cities of Pinole, Hercules, and Martinez to the north; by State Highway 24 and the City of Orinda Village to the south; Interstate 80 and the cities of Berkeley, El Cerrito, and Richmond, to the west; and Interstate 680 and the City of Pleasant Hill to the east. The South end of Unit 1 abuts Unit 6. Land ownership within the unit includes approximately 8,108 ac (3,281 ha) of EBRPD lands, 15 acres (6 ha) of State land, and the remaining 25,997 ac (10,520 ha) under private ownership. The unit contains a complex mosaic of grassland with woody scrub vegetation of several types (PCE 1 and PCE 2), as well as rock outcrops or other talus features (PCE 3) distributed throughout the unit with little habitat fragmentation. Alameda whipsnake records occur within the unit and are uniformly distributed throughout the unit (Swaim 2005a). The dates of Alameda whipsnake records span a time period from before the subspecies' listing to after the time of listing (1986 to present). Habitat fragmentation is minimal. Very limited development has occurred within the unit, with the exception of a few structures presumably associated with livestock management. The distribution of essential features throughout the unit and low fragmentation allows Alameda whipsnakes to utilize and freely disperse within the unit, making the overall population less vulnerable to local extirpation which could result from fire, landslide, or some other natural event (e.g., drought, disease). The unit is designated critical habitat because it contains features essential to the conservation of the Alameda whipsnake, is currently occupied, and represents the northwestern portion of the subspecies' range and one of five population centers. The special management actions that may be required within the unit include prescribed burns and management of grazing activities to maintain a mosaic of open habitat. Additional special management actions that may be required for this unit include management of trespass, unauthorized trail construction, dumping, and/or feral animals, and other activities or situations associated with the urban or recreational interface.

Unit 2: Oakland-Las Trampas; Contra Costa and Alameda Counties (24,436 ac (9,889 ha)). Unit 2 is located south of State Route 24, north of Interstate 580, east of State Route 13, and west of Interstate 680 and the cities of Danville, San Ramon, and Dublin. The North edge of Unit 2 abuts Unit 6. Land ownership includes 4,386 ac (1,775 ha) of EBRPD and East Bay Municipal Utilities District lands and 20,050 ac (8,114 ha) under private ownership. Unit 2 contains a range of vegetation (PCE 1 and PCE 2), soil types, and rocky features (PCE 3) essential to the conservation of the subspecies, supports viable Alameda whipsnake populations, and has minimal development such as roads and structures (Swaim 2005a). Areas with development or reduced soil and vegetation characteristics have not been included in the critical habitat for this unit. Unit 2 essential features that contain more dense woodland habitat may be subject to special management considerations, such as prescribed burns, to improve the habitat quality and enhance the potential for Alameda whipsnake movement between units. Additional special management actions that may be required throughout this unit include management of trespass, unauthorized trail construction, dumping, and/or feral animals, and other activities or situations associated with the urban or recreational interface. Alameda whipsnake occurrences have been documented by multiple records within the unit as well as adjacent to the unit (Swaim 2005a). Dispersal of snakes between Units 2 and 1 is possible only through Unit 6, and impediments to such movement do not appear to be present. Unit 2 is included in the critical habitat because it contains features essential to the conservation of the Alameda whipsnake, is currently occupied by the subspecies, and represents the central distribution of Alameda whipsnake and one of the five population centers.

Unit 3: Hayward-Pleasanton Ridge; Alameda County (25,966 ac (10,508 ha)). Unit 3 is located immediately to the west of Interstate 680 and to the south of Interstate 580. Land ownership includes 404 ac (163 ha) of EBRPD land and 25,562 ac (10,345 ha) privately owned land. We have excluded the Stonebrae Country Club project site from critical habitat in this unit (see Relationship of Critical Habitat to Approved Management Plans— Exclusions Under Section 4(b)(2) of the Act, below). Unit 3 contains the mosaic of scrub and chaparral vegetation and rocky outcrops (PCE 1, PCE 3) considered essential to the conservation of the subspecies. The unit also includes variation in vegetation patch size, abundant edge between grassland and woodland, and a minimal amount of development or planned development. The area supports scrub and rock outcrop features essential for Alameda whipsnake. The Alameda whipsnake records within this unit are associated with Gaviota rocky sandy loams in particular, which likely provide talus (PCE 3), and appear to coincide in aerial imagery to scrub or chaparral vegetation preferred by Alameda whipsnake. Vegetation is largely of oak woodland community of variable densities (PCE 2) and statures (trees, shrubs) interspersed with grassland. Some peripheral portions of habitat around this unit were not included as critical habitat due to the high degree of development-related disturbance and fragmentation of the habitat. The unit is included in the designated critical habitat because it contains features essential to the conservation of the Alameda whipsnake; is currently occupied by the subspecies (Swaim 2005a); and represents the southwestern portion of the subspecies' range and one of the five population centers. The special management actions that may be required throughout this unit include management of controlled burns and grazing, trespass, unauthorized trail and road construction, dumping, and/or feral animals, and other activities or situations associated with the urban or recreational interface.

Unit 4: Mount Diablo-Black Hills; Contra Costa and Alameda Counties (23,225 ac (9,399 ha)). This unit encompasses Mount Diablo State Park and surrounding lands, and is largely within Contra Costa County except a small portion that is within Alameda County. Lands are owned by the Bureau of Land Management (23 ac (9 ha)), State Department of Parks and Recreation (13,855 ac (5,607 ha)), and private landowners (9,348 ac (3,783 ha)). We have excluded East Bay Regional Park District lands and lands covered by the draft East Contra Costa County Habitat Conservation Plan and Natural Community Conservation Plan from critical habitat in this unit (see Relationship of Critical Habitat to Approved Management Plans— Exclusions Under Section 4(b)(2) of the Act'', below). Numerous Alameda whipsnake observations (i.e., greater than 90 records from 1972 to 2004) occur throughout the area, many of which are associated with dense rock outcrops (PCE 3) and chaparral, scrub, and oak woodland (PCE 1, PCE 2). The pattern of woody vegetation with grassland and rock outcrops forms an intricate landscape mosaic that is highly functional habitat for the Alameda whipsnake. The vegetation and soil characteristics, the mosaic habitat pattern, the abundance of Alameda whipsnake records, and the lack of surrounding development and relative absence of roadways, together indicate that this unit likely provides some of the very highest quality and largest contiguous blocks of habitat within the range of the subspecies, as well as some of its most robust populations. Special management, such as prescribed burns, may be required for portions of the unit with dense vegetation. The special management actions which may be required throughout this unit include management of controlled burns and grazing, trespass, unauthorized trail and road construction, dumping, and/or feral animals, and other activities or situations associated with the urban or recreational interface. The unit is included in designated critical habitat because it contains features essential to the conservation of the Alameda whipsnake, is occupied by the subspecies (Swaim 2005a), and represents the northeastern portion of the subspecies' range and one of the five population centers.

Unit 5A: Cedar Mountain; Alameda and San Joaquin Counties (24,723 ac (10,005 ha)). Unit 5A is located east of Lake Del Valle along Cedar Mountain Ridge and Crane Ridge to Corral Hollow west of Interstate 580. Land ownership within this unit includes approximately 2,492 ac (1,008 ha) of Department of Energy land, 246 ac (99 ha) of EBRPD land, and 21,986 ac (8,897 ha)) are privately owned. The vegetation pattern within this unit consists of various woodland, scrub, and/or chaparral communities on northeast-facing slopes (PCE 1, PCE 2). Rock bearing soils which are associated with multiple Alameda whipsnake records (e.g. Vallecitos rocky loam) as well as rock lands are abundant, indicating the presence of PCE 3. Open, grassland-dominated communities are prominent on southwest-facing slopes, but there is also a significant component of woodland habitat on these slopes. Significant areas of vegetation types known to support Alameda whipsnake are present, including coastal oak, chamise-chaparral, mixed chaparral, blue-oak-foothill pine woodland, blue oak woodland, valley oak woodland, and montane hardwood. About 50 Alameda whipsnake records from 1973 through 2002 are known in this unit (Swaim 2005a). In most instances, the boundaries for critical habitat designation correspond to natural breaks in plant communities, habitat quality, and/or landform (ridgelines, water features). A moderate number of light duty roads (e.g., paved or unpaved lightly used) are present within the unit, although there are very few structures or other land modifications. Special management, such as prescribed burns, may be required for portions of the unit with dense vegetation. The special management actions that may be required throughout this unit include management of grazing, trespass, unauthorized trail and road construction, dumping, and/or feral animals, and other activities or situations associated with urban or recreational interface. The unit is included in designated critical habitat because it contains features essential to the conservation of the Alameda whipsnake, is currently occupied by the subspecies, and represents the southernmost and easternmost distribution of Alameda whipsnake and one of five population centers for the subspecies. Unit 5B: Alameda Creek; Alameda and Santa Clara Counties (18,214 ac (7,371 ha)). This unit is located northeast of Calaveras Reservoir, south of the town of Sunol, including the area along Wauhab Ridge in Alameda County and Oak Ridge in Santa Clara County. Alameda Creek is located at the west margin of the unit, and the unit contains the Sunol Regional Wilderness and Camp Ohlone Regional Park (approximately 361 ac (146 ha)), which are managed by the East Bay Regional Park, with the remaining 17,854 ac (7,225 ha) in private ownership. Vegetation is a mix of blue oak—foothill pine and annual grassland with a significant amount of woodland patches. Coastal live oak is present in the vicinity of Lleyden Creek. Soil types in which Alameda whipsnakes are found dominate the unit. This subunit contains six Alameda whipsnake records documented between 1972 and 2000 (Swaim 2005a). Significant areas of vegetation types known to support Alameda whipsnake are present, including coastal oak, chamisechaparral, mixed chaparral, blue oak— foothill pine woodland, blue oak woodland, valley oak woodland, and montane hardwood interspersed with rock outcrops or talus (PCEs 1, 2, 3). The boundaries for critical habitat designation correspond to natural breaks in plant communities, soil type, and or landform. A moderate number of light roads are present within the unit, although there are very few structures or other land modifications. Development within or adjacent to the unit is minimal. As a result of this low development pressure, the survey efforts for the Alameda whipsnake in this unit have not been as extensive as in the other units. Special management, such as prescribed burns, may be required for portions of the unit with dense vegetation. Other special management actions which may be required throughout this unit includes management of grazing, unauthorized trail and road construction, dumping, and/or feral animals, control and other activities or situations associated with urban or recreational interface. The unit is included in designated critical habitat because it contains features essential to the conservation of the Alameda whipsnake, is currently occupied, and represents the southern most distribution of Alameda whipsnake and one of the five population centers for the subspecies.

Unit 6: Caldecott Tunnel; Contra Costa and Alameda Counties (4,151 ac (1,680 ha)). This critical habitat unit lies between Units 1 and 2, along the Alameda and Contra Costa County lines. Land ownership within this unit includes 265 ac (107 ha) of East Bay Regional Park lands, 720 ac (291 ha) of State, and 3,166 ac (1,281 ha) in private lands. The unit is bounded by dense urban development to the east and west. However, the vegetation and soil types that are known to support Alameda whipsnake are dominant throughout the unit (PCEs 1, 2, 3). About eight Alameda whipsnake records are known from the unit between 1990 and 2002 (Swaim 2005a). Special management considerations in this unit include possible consolidation of existing roads, or limiting additional road construction in order to preserve a corridor function in this unit as a consequence of the restricted width of the unit and the current presence of a moderate number of roads. Prescribed burns may also be required to maintain the habitat mosaic considered essential. The unit is included in designated critical habitat because it contains features essential to the conservation of the Alameda whipsnake, is currently occupied, and represents the last remaining habitat connecting Unit 1 and Unit 2, which are two of the five population centers for the subspecies. Maintaining connectivity between units allows for dispersal between units for the subspecies and allows for genetic exchange among all three units.

Unit 5B—Alameda Creek Unit - Alameda and Santa Clara Counties (18,214 ac (7,371 ha)) This unit is located northeast of Calaveras Reservoir, south of the town of Sunol, including the area along Wauhab Ridge in Alameda County and Oak Ridge in Santa Clara County. Alameda Creek is located at the west margin of the unit, and the unit contains the Sunol Regional Wilderness and Camp Ohlone Regional Park (approximately 361 ac (146 ha)), which are managed by the East Bay Regional Park, with the remaining 17,854 ac (7,225 ha) in private ownership. Vegetation is a mix of blue oak—foothill pine and annual grassland with a significant amount of woodland patches. Coastal live oak is present in the vicinity of Lleyden Creek. Soil types in which Alameda whipsnakes are found dominate the unit. This subunit contains six Alameda whipsnake records documented between 1972 and 2000 (Swaim 2005a). Significant areas of vegetation types known to support Alameda whipsnake are present, including coastal oak, chamisechaparral, mixed chaparral, blue oak— foothill pine woodland, blue oak woodland, valley oak woodland, and montane hardwood interspersed with rock outcrops or talus (PCEs 1, 2, 3). The boundaries for critical habitat designation correspond to natural breaks in plant communities, soil type, and or landform. A moderate number of light roads are present within the unit, although there are very few structures or other land modifications. Development within or adjacent to the unit is minimal. As a result of this low development pressure, the survey efforts for the Alameda whipsnake in this unit have not been as extensive as in the other units. Special management, such as prescribed burns, may be required for portions of the unit with dense vegetation. Other special management actions which may be required throughout this unit includes management of grazing, unauthorized trail and road construction, dumping, and/or feral animals, control and other activities or situations associated with urban or recreational interface. The unit is included in designated critical habitat because it contains features essential to the conservation of the Alameda whipsnake, is currently occupied, and represents the southern most distribution of Alameda whipsnake and one of the five population centers for the subspecies.

Primary Constituent Elements/Physical or Biological Features

Critical habitat units are designated for Alameda, Contra Costa, San Joaquin, and Santa Clara counties, California. The primary constituent elements (PCEs) of critical habitat for the Alameda whipsnake (Masticophis lateralis euryxanthus) are the habitat components that provide:

(i) Scrub/shrub communities with a mosaic of open and closed canopy: Scrub/shrub vegetation dominated by low- to medium-stature woody shrubs with a mosaic of open and closed canopy, as characterized by the chamise, chamise-eastwood manzanita, chaparral whitethorn, and interior live oak shrub vegetation series occurring at elevations from sea level to approximately 3,850 feet (1,170 meters). Such scrub/shrub vegetation within these series form a pattern of open and closed canopy used by the Alameda whipsnake for shelter from predators; temperature regulation, because it provides sunny and shady locations; prey-viewing opportunities; and nesting habitat and substrate. These features contribute to support a prey base consisting of western fence lizards and other prey species such as skinks, frogs, snakes, and birds.

(ii) Woodland or annual grassland plant communities contiguous to lands containing PCE 1: Woodland or annual grassland vegetation series comprised of one or more of the following: Blue oak, coast live oak, California bay, California buckeye, and California annual grassland vegetation series. This mosaic of vegetation supports a prey base consisting of western fence lizards and other prey species such as skinks, frogs, snakes, and birds, and provides opportunities for: Foraging, by allowing snakes to come in contact with and visualize, track, and capture prey (especially western fence lizards, along with other prey such as skinks, frogs, birds); short and long distance dispersal within, between, or adjacent to areas containing essential features (i.e., PCE 1 or PCE 3); and contact with other Alameda whipsnakes for mating and reproduction.

(iii) Lands containing rock outcrops, talus, and small mammal burrows. These areas are used for retreats (shelter), hibernacula, foraging, and dispersal, and provide additional prey population support functions.

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.

Special management may be needed to reduce the effects of development projects that remove or reduce the quality of features essential to the subspecies’ conservation.

Special management may be required to manage fuel loads to minimize the risk of catastrophic fire within the six critical habitat units.

Special management may be needed to manage grazing practices so they do not result in incompatible losses of scrub, and to restore scrub habitat to areas within the six critical habitat units that have been adversely affected by past overgrazing or associated land management.

Special management may be needed to ensure that the locations and densities of such features and activities within all six critical habitat units are managed so effects on the Alameda whipsnake and its habitat are minimized.

Special management of nonnative predators may be required within all six critical habitat units.

Life History

Feeding Narrative

<u>Adult:</u> Alameda whipsnakes are opportunistic and active daytime predators. They prey extensively on western fence lizards (Sceloporus occidentalis), and are often used as an example

of a feeding specialist (USFWS 2005). When hunting, the Alameda Whipsnake commonly moves with its head held high and occasionally moves it from side to side to peer over grass or rocks for potential prey (USFWS 2005). Prey is apprehended quickly, pinioned under loops of the body, and engulfed without constriction. In addition to western fence lizards, Alameda whipsnakes feed on a variety of secondary prey; frogs (Pseudacris sp. and Lithobates sp.), skinks (Scincidae sp.), alligator lizards (Elgaria sp.), snakes, small birds, amphibians, single-slender salamanders (Batrachoseps attenuatus), small mammals, fish, and insects are also important in the whipsnake's diet (NatureServe 2015; USFWS 2005; USFWS 2011).The Alameda whipsnake is semi-arboreal and can escape into or hunt in shrubs or trees. Adult Alameda whipsnakes have a bimodal seasonal activity pattern, with peaks during the spring mating season and smaller peak during late summer and early fall. They generally retreat to winter hibernacum in November and emerge in March; however, short periods of aboveground activity such as basking in the immediate vicinity of the hibernaculum may occur during this time. The Alameda is an active daytime predator (USFWS 2011). Rock outcrops are an important feature of their habitat, because they provide retreat opportunities for whipsnakes and promote lizard populations (USFWS 2005).

Reproduction Narrative

Adult: Alameda whipsnakes are ovoviviparous and have been observed in polyandrous partnerships. Courtship and mating occur from late March through mid-June. During this time, males have been found to move throughout their home range, and females have been found to remain at or near their hibernaculum until mating is complete. A female was observed copulating with more than one male during a mating season, but the extent to which females mate with multiple males (polyandry) is unknown. Suspected egg-laying sites were located in patches of grassland, within 3 to 6 m (10 to 20 ft.) of coastal scrub, and were also found in areas of low density scattered scrub intermixed with grassland. Rock outcrops or talus, small rodent burrows, brush piles, and deep soil crevices are essential for normal behaviors such as breeding, reproduction, and foraging, because they provide egg-laying sites, refuge from predators, thermal cover, shelter, winter hibernacula, and increased foraging opportunities (USFWS 2011).Sperm is stored by the male over winter, and copulation commences after emergence from winter hibernacula. Females begin yolk deposition in mid-April, and intervals of 47, 50 and 55 days have been recorded between dates of first known mating and first egg laid. The average clutch size was found to be 7.21 (with a range of 6 to 11), with a significant correlation between body size and clutch size. Incubation lasts about 3 months, and young appear in late summer and fall (USFWS 2011).Hatchlings have been observed or captured above ground from August through November. Hatchlings have been observed with prey in their stomachs prior to winter hibernation, indicating parental care. California whipsnakes (Masticophis lateralis) reach maturity in 2 to 3 years, with adults growing to nearly 1.5 m (5 ft.). Based on a study of captive California whipsnakes, they may live for 8 years (USFWS 2011).

Geographic or Habitat Restraints or Barriers

Adult: Habitat was directly lost to urban growth; fragmentation due to freeway construction and commercial and residential developments also created barriers to species dispersal, further isolating populations and subpopulations (USFWS 2011).

Spatial Arrangements of the Population

Adult: Clumped according to resources.

Environmental Specificity

Adult: Community with all key requirements

Tolerance Ranges/Thresholds

Adult: Moderate

Site Fidelity

Adult: Moderate

Dependency on Other Individuals or Species for Habitat

Adult: Whipsnakes require small mammal burrows for temperature regulation, egg-laying sites, refuge from predators, and winter hibernaculum (winter residence where the snakes hibernate (65 FR 12155).

Habitat Narrative

Adult: Alameda whipsnakes are typically associated with small to large patches of chaparral or coastal scrub vegetation, interspersed with other native vegetation types and rock lands (areas containing large percentage of rocks, rocky features, and/or rock-bearing soil types). Alameda whipsnakes were also observed using adjacent vegetation types, including grassland, oak savanna, and oak-bay woodland, up to 150 m (500 ft.) from coastal scrub and chaparral. Alameda whipsnakes use all slope aspects and brush community canopy closures, but were found to be concentrated on slopes facing south, southwest, southeast, east, or northeast. Alameda whipsnakes usually had more than one core area, separated by more northerly aspects. Northerly aspects were used on a regular basis to move between core areas. Selection for southerly and easterly aspects is likely related not only to consistently warmer temperatures, but is also associated with the availability of morning sun, which promotes emergence earlier in the day and maximizes the activity period for foraging, mate finding, and digestion (USFWS 2011).Chaparral and coastal scrub vegetation serve as the center of home ranges, providing for foraging opportunities and concealment from predators. Core areas have been found to center around patches of coastal scrub or chaparral as small 0.2 hectare (ha) (0.5 acre [ac.]) embedded in a mosaic of other dominant vegetation types (USFWS 2011).Whipsnakes also require rock outcrops or talus. Small rodent burrows are important retreats, and brush piles and deep soil crevices can also serve as important habitat features. These habitat features are essential for normal behaviors such as breeding, reproduction, and foraging, because they provide egg-laying sites, refuge from predators, thermal cover, shelter, winter hibernacula, and increased foraging opportunities. Whipsnake habitat was directly lost to urban growth; fragmentation due to freeway construction and commercial and residential developments also created barriers to species dispersal, further isolating populations and subpopulations (USFWS 2011).

Dispersal/Migration

Motility/Mobility

Adult: High mobility

Migratory vs Non-migratory vs Seasonal Movements

Adult: Nonmigratory (NatureServe 2015)

Dispersal

Adult: Moderate

Immigration/Emigration

Adult: Unlikely

Dispersal/Migration Narrative

Adult: Alameda whipsnakes are nonmigratory species with a home range varying in size from 1.9 to 9.7 ha (4.7 to 24 ac.). Individuals monitored for nearly an entire activity season appeared to maintain stable home ranges. Movements of these individuals were multi-directional, and they returned to specific areas and retreat sites after long intervals of non-use. Alameda whipsnakes have been found to have one or more core areas (areas of primary use) within their home range, with large areas of the home range receiving little use. Core areas of the Alameda whipsnake most commonly occur on slopes facing east, south, southeast, and southwest. However, recent information indicates that whipsnakes do make use of north-facing slopes in more open stands of scrub habitat. Core areas have been found to center around patches of coastal scrub or chaparral as small 0.2 ha (0.5 ac.) embedded in a mosaic of other dominant vegetation types (USFWS 2011).Little to no habitat connectivity occurs between the Mount Diablo Area population and any other population. Interstate Highway 680 and associated urban development constitute barriers to dispersal between the Mount Diablo Area and the East Bay Hills; Interstate Highway 580 and the expansive grasslands of the Tri-Valley constitute barriers to dispersal between the Mount Diablo Area and the northern Hamilton Range (USFWS 2011). Compared to the much more common chaparral whipsnake, the Alameda subspecies' historic range has always had a very restricted distribution. It most likely included all of the coastal scrub and oak woodland communities in the East Bay in Contra Costa, Alameda, and parts of San Joaquin and Santa Clara counties (USFWS 2005).

Additional Life History Information

Adult: Little to no habitat connectivity occurs between the Mount Diablo Area population and any other population. Interstate Highway 680 and associated urban development constitute barriers to dispersal between the Mount Diablo Area and the East Bay Hills; Interstate Highway 580 and the expansive grasslands of the Tri-Valley constitute barriers to dispersal between the Mount Diablo Area and the northern Hamilton Range. Within the five populations, there are varying degrees of isolation due to natural and human-caused barriers. Therefore, there may be some subpopulations within each population that are geographically and genetically isolated, and others that may contribute to gene flow within each population. The boundaries of these five populations and the two corridors represent the extent of suitable habitat that includes known Alameda whipsnake locations (USFWS 2011). Movement is multi-directional; individuals return to specific areas and retreat sites after long intervals of non-use. Alameda whipsnakes have been found to have one or more core area (area of concentrated use) within their home range, with large areas of the home range receiving little use. Core areas of the Alameda whipsnake most commonly occur on slopes facing east, south, southeast, and southwest. However, recent information indicates that whipsnakes do make use of north-facing slopes in more open stands of scrub habitat. Core areas have been found to center around patches of coastal scrub or chaparral as small 0.2 ha (0.5 ac.) embedded in a mosaic of other dominant vegetation types (USFWS 2011).

Population Information and Trends

Population Trends:

Decline of 10 to 30 percent (NatureServe 2015).

Species Trends:

Declining (NatureServe 2015)

Number of Populations:

Five populations organized into recovery units: 1) Tilden–Briones; 2) Oakland–Las Trampas; 3) Hayward–Pleasanton Ridge; 4) Mount Diablo–Black Hills; and 5) Sunol–Cedar Mountain (USFWS 2002).

Resistance to Disease:

Moderate

Adaptability:

Moderate

Additional Population-level Information:

In the five populations, there are varying degrees of isolation due to natural and human-caused barriers; these result in varied gene flow within populations and little to none between populations. The boundaries of these five populations and two associated dispersal corridors represent the extent of suitable habitat that includes known Alameda whipsnake locations. Remaining natural habitat in these areas may provide movement corridors for the Alameda whipsnake, but it is as yet unknown whether whipsnakes are able to use these corridors in a manner that would promote gene flow (USFWS 2002; USFWS 2011).

Population Narrative:

The current population size, trend levels, and minimum viable population size are undescribed. There are five populations (corresponding to the species' recovery units) within a fragmented regional metapopulation: 1) Tilden–Briones; 2) Oakland–Las Trampas; 3) Hayward–Pleasanton Ridge; 4) Mount Diablo–Black Hills; and 5) Sunol–Cedar Mountain. Two additional recovery units are associated with movement corridors: Caldecott Tunnel Corridor and Niles Canyon/Sunol Corridor (USFWS 2002; USFWS 2011). Population and species-level trends are assumed to be in decline (a short-term decline of 10 to 30 percent), based on the continued habitat loss, alteration, and fragmentation of known extant habitat (NatureServe 2015; USFWS 2011). In the five populations, there are varying degrees of isolation due to natural and human-caused barriers; these result in varied gene flow within populations and little to none between populations. The boundaries of these five populations and two associated dispersal corridors represent the extent of suitable habitat that includes known Alameda whipsnake locations. Remaining natural habitat in these areas may provide movement corridors for the Alameda whipsnake, but it is as yet unknown whether whipsnakes are able to use these corridors in a manner that would promote gene flow (USFWS 2002; USFWS 2011).Little population abundance data exists for the Alameda whipsnake. However, Alameda whipsnakes have been found to be locally abundant and the dominant snake species when habitat quality is high. Almost all trapping studies targeting this species have been designed to determine presence or absence for regulatory purposes and assessing impacts to potential habitat. Monitoring is therefore most often habitat based, assuming snake abundance is positively correlated with the amount of coastal scrub or chaparral vegetation and rock lands present. No studies have been performed that have quantified Alameda whipsnake densities relative to habitat quality or quantity (USFWS 2011).

Threats and Stressors

Stressor: Urban development and loss of habitat
Exposure: Direct
Response: Mortality and reduced habitat.
Consequence: Reduction in population numbers.
Narrative: Urbanization and habitat destruction are the greatest threats to the Alameda whipsnake throughout much of its range. Environmental impacts associated with urbanization are loss of habitat, reduction of grassland habitat, alteration of natural fire regimes, water diversion, fragmentation of habitat due to road construction, and degradation of habitat due to pollutants. Substantial losses of coastal scrub and chaparral vegetation have resulted from urban development that expanded into these vegetation types from lower elevation valleys and coastal cities. Urbanization increasingly threatens the viability of Alameda whipsnake populations as urban landscapes and transportation corridors encroach on ever-diminishing habitats. The historic loss of habitat from encroaching urban development pressures surrounding the East Bay Hills and the highly fragmented state of these areas were the primary threats leading to the listing of the Alameda whipsnake (USFWS 2011).

Stressor: Water development projects
Exposure: Water storage reservoirs
Response: Fragmentation and loss of habitat.
Consequence: See narrative.
Narrative: Numerous water storage reservoirs were constructed throughout the range of the Alameda whipsnake (i.e., San Pablo, Briones, Lake Chabot, and Upper San Leandro reservoirs). These reservoirs resulted in the inundation and large scale losses and fragmentation of Alameda whipsnake habitat. In the East Bay Municipal Utility District's Water Supply Management Program 2040, the option was considered of building a dam and reservoir along 7 miles of Buckhorn Canyon for the purpose of increasing water supply in the San Francisco East Bay. Although this option was eliminated early on due to numerous environmental concerns by stakeholders, including the loss of Alameda whipsnake habitat, the option to inundate Buckhorn Canyon or other areas occupied by the Alameda whipsnake could become less controversial and be a viable solution to meet water demand for local water districts if a lack of water supply threatened the economic livelihood and welfare of the public (USFWS 2011).

Stressor: Wildfire fuel reduction treatments
Exposure: Direct
Response: Increased wildfires throughout whipsnake habitat.
Consequence: Loss of habitat, increased habitat fragmentation, and in some cases mortality.
Narrative: Fire suppression indirectly threatens the Alameda whipsnake by allowing plants to establish a closed canopy that tends to create relatively cool conditions that are less suitable to the Alameda whipsnake, which maintains a relatively high active body temperature. The East Bay Regional Park District developed a Wildfire Hazard Reduction and Resource Management Plan (WHRRMP) to reduce fuel loads in the Wildland Urban Interface of the Oakland/Berkeley Hills. According to the WHRRMP, core Alameda whipsnake habitat will be mechanically treated to reduce fuel loads. Loss of Alameda whipsnake core habitat from wildfire fuel reduction

treatments represents a moderate threat to the species. The threat of closed canopied stands represents a greater threat on cooler sites. In addition, because chaparral and coastal scrub can be converted to other vegetation types by increasing fire frequency, a too frequent fire return interval also represents a threat to the species (USFWS 2011).

Stressor: Fire frequency
Exposure: Indirect
Response: Changes in suitable habitat.
Consequence: See narrative.
Narrative: It has been determined that the natural fire return interval for the San Francisco East Bay is 10 to 30 years, and that fire suppression has exacerbated the effects of wildfires by allowing a buildup of fuels, creating the conditions for hotter fires that may directly kill Alameda whipsnakes that do not find retreat in burrows or rock crevices. The effects of fire suppression indirectly threaten the Alameda whipsnake by allowing plants to establish a closed canopy that will tend to create relatively cool conditions that are less suitable to the Alameda whipsnake, which maintains a relatively high active body temperature. There is much debate over the potential effect to the whipsnake caused by irregular fire regimes. The whipsnake's desired chaparral habitat should not be considered a fire-adapted vegetation type, but rather one adapted to a particular fire regime. Determining the natural fire regime is also complicated because humans have set fires in the region for hundreds to thousands of years. Although the natural fire regime has proven difficult to determine, extremely short intervals between fire events can threaten the persistence of some shrub species or irreversibly convert chaparral to other vegetation types, such as coastal scrub or nonnative annual grasslands. Based on analysis of fire frequency in California shrubland ecosystems and the effects of fire suppression on stand structure and fire behavior, it is no longer believed that fire suppression significantly exacerbates the effects of wildfires in chaparral and coastal scrub vegetation types. Based on this, it does not appear that prescribed fire can be effectively used to maintain open canopied stands of chaparral or coastal scrub. However, because periodic wildfire is considered necessary to maintain a full suite of native chaparral and scrub plant species, and because many of these species depend on fire cues (heat, smoke, and/or charate) for germination, fire suppression remains a threat to the Alameda whipsnake (USFWS 2011).

Stressor: Nonnative invasive species
Exposure: Indirect
Response: Decreased ability to forage and regulate body temperature.
Consequence: Reduction in population numbers.
Narrative: Alameda whipsnake habitat has become fragmented, isolated, and otherwise degraded by human activities; increased predatory pressure may become excessive, especially where alien species, such as rats (Rattus species), feral pigs (Sus scrofa), and feral and domestic cats (Felis domestica) and dogs (Canis familiaris), are introduced (USFWS 2011). The presence of nonnative plant species is also a significant concern for the Alameda whipsnake. Chaparral and coastal scrub ecosystems are composed of plant species that are most often shade-intolerant. The ability of nonnative trees and shrubs to colonize chaparral, coastal scrub, and grassland ecosystems has led to inhibited growth of native plants, vegetation type conversion, changes in microclimates and soil chemistry, increased sediment mobilization, increased fuel loads, an overall reduction in habitat quality, and overall reductions in quantity of core habitat and peripheral dispersal and foraging habitat. Nonnative invasive plant species represent a substantial threat to the habitat of the Alameda whipsnake (USFWS 2011).

Stressor: Succession
Exposure: Indirect
Response: Increase in unsuitable habitat.
Consequence: Decreased dispersal and an increase in unsuitable habitat.
Narrative: Succession of core Alameda whipsnake habitat is occurring, from coastal scrub and chaparral to other native vegetation types. It is hypothesized this succession is due to the removal of disturbance regimes. This threat is greatest on more mesic sites where fire and grazing have been removed, particularly on sites in the fog belt in the East Bay Hills. However, the rate of succession and the possibility of a net loss in coastal scrub or chaparral that has or is likely to occur are unknown at this time. In some locations, mosaics of grassland, oak woodland, coastal scrub, and chaparral have been reported to correlate with geological substrate and soil characteristics. Although stands of coastal scrub and chaparral are succeeding to other vegetation types, it is also true that grasslands are succeeding to coastal scrub in the San Francisco East Bay. These changes lead to decreased dispersal and an increase in unsuitable habitat. The effect of succession represents a moderate threat to the Alameda whipsnake and warrants further research (USFWS 2011).

Stressor: Grazing
Exposure: Indirect
Response: Increase the invasive abilities of nonnative plants.
Consequence: Increased loss of Alameda whipsnakes and their prey to predation.
Narrative: Because Alameda whipsnakes forage in grasslands between stands of scrub, livestock grazing that significantly reduces or eliminates plant cover in these grasslands could lead to an increased loss of Alameda whipsnakes and their prey to predation. It is also indicated that livestock grazing, if appropriately managed, could benefit the Alameda whipsnake. At this time, a moderate threat to the species is posed by incompatible grazing practices that result in significant and long-term losses of scrub vegetation or a loss of hiding cover, such as overgrazing or bulldozing and burning to prepare lands for grazing. Overgrazing may also negatively affect Alameda whipsnakes by damaging the rodent burrows these snakes use for cover. Grazing animals can also act as vectors for nonnative invasive plant species and increase the invasive abilities of nonnative plants through ground disturbance and the removal of native vegetation. However, through appropriate timing and stocking levels, grazing can be used to target and control some nonnative invasive plant species (USFWS 2011).

Stressor: Roads, off-highway vehicles, and trails
Exposure: Direct
Response: Increased human interactions.
Consequence: Physical injury, loss of suitable habitat, and mortality.
Narrative: Loss and fragmentation of habitat as a result of road and trail construction is a stressor for the Alameda whipsnake. Roads can impede gene flow and dispersal. Networks of roads and trails fragment habitat, reduce patch size, and increase the ratio of edge to interior habitat. Road variables that potentially affect wildlife, both directly and indirectly, include size, substrate, age, accessibility, and density. The potential environmental effects of roads on wildlife include pollutants, noise, light, increased spread of invasive species, and human access. Snakes are particularly vulnerable to motor vehicle mortality associated with roads, due to their propensity to thermoregulate on road surfaces and to humans intentionally killing snakes when observing them on road surfaces. Road placement in the surrounding landscape is possibly the

most important factor determining the severity of road impacts, because it influences road-kill locations and the rate of mortality. Although the presence of hiking and bicycling trails do not result in motor-vehicle-associated mortality of Alameda whipsnakes, heavily trafficked and high-density hiking and bicycling trails can result in harassment or harm by causing snakes to flee and hide when humans are present, thus reducing the overall quality and quantity of habitat. Alameda whipsnakes can also be killed or injured in collisions with cyclists. In addition to the general effects of roads on the Alameda whipsnake, Off-Highway Vehicles continually damage and destroy large patches of habitat and generate high levels of noise that can cause animals to change their behavior, or can result in hearing damage (USFWS 2011).

Stressor: Climate change
Exposure: Indirect
Response: Inability to adapt to changing environmental conditions, and range shifts precluded by lack of habitat.
Consequence: Local extinction.
Narrative: Global climate change increases the frequency of extreme weather events, such as heat waves, droughts, and storms. Extreme events, in turn, may cause mass mortality of individuals and significantly contribute to determining which species will remain or occur in natural habitats. As the global climate warms, terrestrial habitats are moving northward and upward; but in the future, range contractions are more likely than simple northward or upslope shifts. Climate change threatens to disrupt annual weather patterns, and may result in a loss of habitats and/or prey. Where populations are isolated, a changing climate may result in local extinction, with range shifts precluded by lack of habitat (USFWS 2011).

Stressor: Pesticide Effects (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative: The EPA's Environmental Fate and Effects Division completed several pesticide effect determinations that assessed the direct and indirect effects of chemical use on the Alameda whipsnake, and how the use of these chemicals modify Alameda whipsnake critical habitat (Housenger et al. 2012; Odenkirhcen et al. 2010; Hartless et al. 2011; Sternberg et al. 2011). The pesticides analyzed included the anticoagulant rodenticides bromadiolone, brodifacoum, and chlorophacinone (Sternberg et al. 2011; Housenger et al. 2012; Hartless et al. 2011), and aluminum and magnesium phosphides, which are used as fumigants (Odenkirhcen et al. 2010). The assessments determined that all three anticoagulants directly affect the Alameda whipsnake through secondary exposure via prey consumption. Because the Alameda whipsnake targets live prey, it is unlikely to ingest the rodenticide directly; however, prey items that do ingest the poison may not die until several days after ingestion, and Alameda whipsnakes may consume poisoned prey (Sternberg et al. 2011; Housenger et al. 2012; Hartless et al. 2011). The assessments also showed the use of all three anticoagulant rodenticides can result in indirect effects to survival, growth, and reproduction from a reduction in prey and availability of small mammal burrows (Sternberg et al. 2011; Housenger et al. 2012; Hartless et al. 2011). Aluminum and magnesium phosphides are fumigants that are used outdoors to control burrowing mammals. The assessment found that the use of these fumigants can have both direct and indirect effects to the Alameda whipsnake. If any individual whipsnakes were within a burrow that was treated with the fumigant, they would be killed. Indirect effects due to the use of aluminum and magnesium phosphides include a reduction in prey base, reduction in burrowing

mammals, and elimination of burrow habitat when burrows are sealed off during treatment (Odenkirhcen et al. 2010). The use of the chemicals analyzed are primarily concentrated in areas with urban development. Therefore, the Alameda whipsnake is at an increased risk of exposure to these chemicals in developed areas (Housenger et al. 2012; Odenkirhcen et al. 2010; Hartless et al. 2011; Sternberg et al. 2011). (USFWS, 2020)

Stressor: Snake Fungal Disease (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative: In late 2019, the emerging Snake Fungal Disease (SFD) was confirmed in a California kingsnake (Lampropeltis californiae) in Plymouth, Amador County (CDFW 2019). The fungus that causes SFD was also detected on a southern watersnake (Nerodia fasciata) found deceased in Folsom, Sacramento County. Cases of the disease range from mild to life-threatening, and affected snakes are often emaciated (CDFW 2019). During trapping efforts at Sibley Volcanic Preserve and Wildcat Canyon Regional Park (within the range of the Alameda whipsnake), two California kingsnakes and a Pacific ringsnake had noticeable apparent scale infections (Stoelting et al. 2019). Scale clips from one of the California kingsnakes and the Pacific ringneck were tested for the causative agent of SFD and both tested negative (Stoelting et al. 2019). Although it is unknown if or how SFD may affect the Alameda whipsnake, the emerging threat of this disease is of great concern. The California Department of Fish and Wildlife plans increased surveillance and implementation of precautions to minimize risk of anthropogenic spread. (USFWS, 2020)

Stressor: Habitat Loss (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative: Habitat loss and fragmentation due to urban development and the installation of associated infrastructure (i.e., roads, trails, etc.) continues to be a threat to the Alameda whipsnake throughout its range. However, development projects that are subject to Section 7 consultation or result in the issuance of an incidental take permit under the federal Endangered Species Act (Act) typically include habitat compensation, which can reduce the severity of overall habitat loss typically associated with these projects. Habitat compensation can occur via a variety of mechanisms, including the purchase of credits at approved conservation banks, through permittee responsible mitigation, and through the development of Habitat Conservation Plans (HCPs) (USFWS, 2020)

Recovery

Reclassification Criteria:
A final recovery plan has not been issued; however, a draft recovery plan was issued in November 2002 (USFWS 2002). No reclassification criteria have been identified.

Recovery Priority Number: 9C

Delisting Criteria:
A final recovery plan has not been issued; however, a draft recovery plan was issued in November 2002 (USFWS 2002). Delisting criteria included below are from the draft recovery

plan.

Specified recovery areas are secured and protected from incompatible uses (USFWS 2002). a) Protection for 75 to 100 years of 90 percent of “long-term protection” habitat; and b) Permanent protection of 100 percent of focus areas (“protection in perpetuity” habitat, as refined based on spatial analysis and surveys. Areas include population centers, connectivity areas, corridors, and buffer areas).

Management plans oriented to species conservation (and adaptively updated based on current research) are approved and implemented for recovery areas (USFWS 2002). Management plans that have the survival and recovery of the species as objectives are: a) Approved and implemented on 100 percent of all focus areas; b) Approved and implemented on 30 percent of lands outside of focus areas but within the recovery unit boundaries; c) Approved, and implementation has begun in an additional 20 percent of the recovery units outside the focus areas; and d) Assured of adequate funding for long-term management.

Monitoring in recovery areas demonstrates stable or improving trends in species populations and successional diversity of natural habitat (USFWS 2002). a) Representative populations or subpopulations representing the genetic variation and geographic extent of the species, as identified by surveys and genetic study, are stable or increasing with evidence of natural recruitment for a period of 1.5 fire cycles (approximately 60 years) that include normal disturbances; and b) Habitat monitoring shows a mosaic of multi-age class stands, and that habitat fragmentation has not appreciably increased (less than 5 percent) in any recovery unit over current (2002) conditions.

Threats are ameliorated or eliminated, and fire techniques for habitat management are studied and implemented (USFWS 2002).

Achieve a mosaic of habitats, ideally through reestablishment of natural fire frequency (USFWS 2002).

Increased public awareness in the four county area on urban/wildland issues (USFWS 2002).

Recovery Actions:

- A final recovery plan has not been issued; however, a draft recovery plan was issued in November 2002 and contained draft recovery actions. The 2011 5-Year Review also contains recommended actions. Both the draft recovery actions and the recommended actions are presented below (USFWS 2002; USFWS 2011).
- Form a Recovery Implementation Team that cooperatively implements specific management actions necessary to recover the species (USFWS 2002).
- Conduct public outreach and education; and develop and implement a regional cooperative program (USFWS 2002).
- Conduct mapping, assessment, and analysis exercise (USFWS 2002).
- Protect and conserve the ecosystems upon which the species depends (USFWS 2002).
- Protect and secure existing populations and habitat (USFWS 2002).
- Survey historical locations and other potential habitat where this species may occur (USFWS 2002).

- Conduct necessary biological research and use results to guide recovery/conservation efforts (USFWS 2002).
- Prepare management plans and implement appropriate management in areas inhabited by this special-status species (USFWS 2002).
- Augment, reintroduce, and/or introduce this species (USFWS 2002).
- Develop a tracking process for the completion of recovery tasks and the achievement of delisting criteria (USFWS 2002).
- Refine delisting criteria (USFWS 2002)
- Conduct status reviews of the species to determine whether listing as endangered or threatened is necessary (USFWS 2002).
- Assess the applicability, value, and success of this recovery plan to the recovery of Alameda whipsnake every 5 years until the recovery criteria are achieved (USFWS 2002).
- Promote the eradication of blue gum (Eucalyptus globules), Monterey pine (Pinus radiata), Monterey cypress (Cupressus macrocarpa), and French broom (Genista monspessulana), and other nonnative invasive species in the San Francisco East Bay (USFWS 2011).
- Focus land protection efforts on undeveloped parcels in the Wildland Urban Interface to reduce urban sprawl into chaparral and coastal scrub vegetation, and to reduce the need for fuel reduction treatments in Alameda whipsnake habitat (USFWS 2011).
- Conduct a genetic study, using nuclear DNA, to determine the genetic basis for the phenotype and to determine whether there is a geographic boundary separating the Central and the Southern California clades, whether individuals from each of these clades coexist, and whether gene exchange between the two clades occurs (USFWS 2011).
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Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Promote the eradication of Eucalyptus globules, Pinus radiata, Cupressus macrocarpa, Genista monspessulana, and other non-native invasive species in the San Francisco East Bay. 2. Focus land protection efforts on undeveloped parcels in the wildland urban interface to reduce urban sprawl into chaparral and coastal scrub vegetation and to reduce the need for fuel reduction treatments within Alameda whipsnake habitat. 3. Continue research on the Alameda whipsnake's response to various vegetation treatments. 4. Recent observations suggest the subspecies is utilizing habitats that are considered atypical and using patches of typical scrub habitat that appears too small to support the subspecies. Additional studies should be conducted to determine how often the subspecies is utilizing these atypical habitats and how these habitats provide for the subspecies' requirements (i.e., feeding, breeding, basking, etc.). 5. Recent observations suggest the subspecies is more arboreal than previously thought. Additional studies should be conducted to determine how often the subspecies is utilizing trees and large shrubs for activities other than basking. (USFWS, 2020)

Additional Threshold Information:

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SPECIES ACCOUNT: *Neoseps reynoldsi* (Sand skink)

Species Taxonomic and Listing Information

Listing Status: Threatened; Southeast Region (R4) (USFWS, 2015)

Physical Description

The sand skink reaches a maximum length of about 5 inches. The tail makes up about half the total body length. The body is shiny and usually gray to grayish-white in color, although the body color may occasionally be light tan. Hatchlings have a wide black band located along each side from the tip of the tail to the snout. This band is reduced in adults and may only occur from the eye to snout on some individuals (Telford 1959). Sand skinks contain a variety of morphological adaptations for a fossorial lifestyle. The legs are vestigial and practically nonfunctional, the eyes are greatly reduced, the external ear openings are reduced or absent (Greer 2002), the snout is wedge-shaped, and the lower jaw is countersunk.

Taxonomy

Recent morphological (Griffith et al. 2000) and molecular studies (Schmitz et al. 2004, Brandley et al. 2005) have demonstrated that the scincid lizard genus Eumeces, Weigmann (1834) is paraphyletic and that Plestiodon, Dumeril and Bibron (1839) has nomenclatural priority for the American species formally referred to as Eumeces, except for those now placed in the genus Mesoscincus (Smith 2005). Molecular analysis of ribosomal RNA gene sequences also show "Eumeces" egregius and Neoseps reynoldsi are closely related sister species (Schmitz et al. 2004, Brandley et al. 2005). Schmitz et al. (2004) suggested the amount of genetic differentiation between the two species (5 percent) is similar to other species of North American skinks and Neoseps (Stejneger 1910) should be synonymized. They argue sand skinks are a striking example of morphological adaptation for burrowing, where the rate of morpho-ecological change exceeds phylogenetic change. The sand skink is believed to have evolved on the central LWR and radiated from there (Branch et al. 2003). Analysis of mitochondrial DNA (mtDNA) indicates populations of the sand skink are highly structured with most of the genetic variation partitioned among four lineages: three subpopulations on the LWR characterized by high haplotype diversity and a single, unique haplotype detected only on the MDR (Branch et al. 2003). Under the conventional molecular clock, the 4.5% divergence in sand skinks between these two ridges would represent about a 2-million-year separation; the absence of haplotype diversity on the MDR would suggest that this population was founded by only a few individuals or severely reduced by genetic drift of a small population (Branch et al. 2003).

Current Range

The range is restricted to central Florida, USA, where the species is locally abundant on high sandy ridges of Lake, Marion, Orange, Polk, Highlands, and Osceola counties (Christman 1992, Krysko et al. 2011). Formerly this skink was more widespread throughout the Lake Wales Ridge region. It is most common on the Lake Wales and Winter Haven ridges in Highlands, Polk, and Lake counties, and less common on the Mount Dora Ridge, including sites within the Ocala National Forest (see USFWS 1998). (NatureServe, 2015)

Distinct Population Segments Defined

No

Critical Habitat Designated

No;

Life History

Feeding Narrative

Adult: The sand skink is highly adapted for life in the sand. It spends the majority of its time below the surface where it burrows through loose sand in search of food, shelter, and mates. Sand skinks feed on a variety of hard and soft-bodied arthropods that occur below the ground surface. The diet consists largely of beetle larvae and termites (Prorhinotermes spp.). Spiders, larval ant lions, lepidopteran larvae, roaches, and adult beetles are also eaten (Myers and Telford 1965, Smith 1982).

Reproduction Narrative

Adult: The literature states sand skinks lay two eggs typically in May or early June (Ashton 2005) under logs or debris, approximately 55 days after mating (Telford 1959). However, there have been observations of three to four eggs per clutch at times (Mushinsky, personal communication, 2007). The eggs hatch from June through July. Sand skinks first reproduce at 2 years of age and females produce a single clutch in a season, although some individuals reproduce biennially or less frequently (Ashton 2005). Sand skinks can live to at least 10 years of age (Meneken et al. 2005).

Habitat Narrative

Adult: Specific physical structures of habitat that sustain sand skink populations, and likely blue-tailed mole skink populations as well, include a well-defined leaf litter layer on the ground surface and shade from either a tree canopy or a shrub layer, but not both. Leaf litter likely provides important skink foraging opportunities. Shade provided by a tree canopy or a shrub layer likely helps skinks regulate body temperature to prevent overheating. However, having both a tree canopy and a shrub layer appears to be detrimental to skinks (McCoy 2011, University of South Florida, pers. comm.). The sand skink is widespread in native xeric uplands with excessively well-drained soils (Telford 1996), principally on the ridges listed above at elevations greater than 25 m above mean sea level. Various authors have attempted to characterize optimal sand skink habitat (Telford 1959, Campbell and Christman 1982, Christman 1978, 1992a, Service 1993a), but McCoy et al. (1999) have argued these notions are “educated guesswork” (Burgman et al. 1993) with little empirical basis. Commonly occupied native habitats include Florida scrub, variously described as sand pine scrub, xeric oak scrub, rosemary scrub and scrubby flatwoods, as well as high pine communities that include sandhill, longleaf pine/turkey oak, turkey oak barrens and xeric hammock (see habitat descriptions in Myers 1990 and Service 1999). Coverboard transects extended from scrub or high pine (sandhill) through scrubby flatwoods to pine flatwoods revealed sand skinks left more tracks in scrub than the other three habitats and did not penetrate further than 40 m into scrubby flatwoods or 20 m into pine flatwoods (Sutton et al. 1999). Activity – Sand skinks are most active during the morning and evening in spring and at mid-day in winter, the times when body temperatures can easily be maintained between 28°C and 31°C in open sand (Andrews 1994). During the hottest parts of the day, sand skinks move under shrubs to maintain their preferred body temperatures in order to remain active near the surface (Andrews 1994). With respect to season, Telford (1959) reported skinks were most active from early March through early May, whereas Sutton (1996) found skinks were most active from mid-February to late April. Based on monthly sampling of pitfall traps, Ashton and Telford (2006) found captures peaked in March at ABS, but in May at Ocala National Forest (ONF). All of these authors suggested the spring activity peak was associated with mating. At ABS, Ashton and Telford (2006) noted a secondary peak in August that corresponded with the emergence of hatchling sand skinks.

Dispersal/Migration

Migratory vs Non-migratory vs Seasonal Movements

Adult: Non-migratory

Dispersal

Adult: > 240 meters

Dispersal/Migration Narrative

Adult: Information on sand skink dispersal and movement patterns is limited. Sand skink studies in the early 2000s documented dispersal distances of more than 140 m (Mushinsky et al. 2001, Penney 2001, Penney et al. 2001) to more than 240 m (Penney 2001). Evidence suggested smaller sand skinks might move greater distances than larger individuals. Researchers believed these documented sand skink dispersal distances likely underestimated dispersal capability. Information suggests that sand skinks can move more than 1 kilometer (km) at appropriate elevations where suitable soils are contiguous and there are no natural or manmade barriers to movement (Mushinsky et al. 2011a). More recent studies documented the longest sand skink movement at 8 km and an average movement of 1.6 km in naturally fragmented scrubby flatwoods at the Archbold Biological Station (Mushinsky et al. 2011a). Sand skink dispersal distances documented in field studies are supported by sand skink genetic research. Genetic relatedness of sand skinks was similar between individuals captured as far as 1 to 2 km from one another (Schrey et al. 2010). Sand skink genetic relatedness tended to decline beyond the 1 km distance, although it appeared to be influenced by the time since fire (Schrey et al. 2010, Mushinsky et al. 2011b). Fires that occur too frequently could negatively decrease sand skink genetic diversity.

Population Information and Trends

Number of Populations:

124 (USFWS, 2023)

Population Narrative:

The Service has little information on the population dynamics of sand skinks within their extant ranges. The skinks' diminutive size and secretive habits make their study difficult. As noted above, sand skinks can reach densities of up to 650 individuals/ha (263/ac) in high quality habitat, particularly on the LWR. Delayed maturity (2 years), a small clutch size (two eggs) of relatively large eggs, low frequency of reproduction, and a long lifespan in sand skinks are life-history traits that also characterize a number of other fossorial lizards that occur in high densities (Ashton 2005). Such character traits may reflect high intra-specific competition and/or predation (Ashton 2005). In contrast, blue-tailed mole skinks often seem absent or rare on the same LWR study sites where sand skinks are common, and when present, are patchily distributed (Christman 1988, 1992b; Mushinsky and McCoy 1995). Mount (1963) noted peninsula mole skinks also are patchily distributed and mostly occurred on xeric sites greater than 100 acres (40 ha) in size. Early maturity (1 year in laboratory) and a large clutch size (maximum = nine eggs) of relatively small eggs (Mount 1963) suggest the population dynamics of mole skinks are different from sand skinks. The sand skink, listed as Neoseps reynoldsi, has been reclassified into the genus Plestiodon by the scientific community based on recent phylogenetic research, but remains a valid entity. There are currently 124 populations range-wide, spread across seven representative units that reflect observed and assumed genetic differentiation. Currently, three representative units exhibit very high resiliency, while four representative units exhibit low or very low resiliency based on an assessment of the area, management, and fragmentation of primary sand skink habitat. Sixtythree populations occur within the representative units with very high resiliency, and 61 populations occur within the representative units with low or very low resiliency. However, the number of populations must be interpreted with caution as the high number of isolated populations is likely a consequence of increasing fragmentation of a smaller number of connected populations. The representative unit with the highest number of populations at 45 also contains the smallest populations in terms of habitat area per population. This could result in a loss of genetic diversity. Genetic diversity has been studied for five of the representative units. Of the three units with the highest genetic diversity, two exhibit relatively high resiliency (Lake Wales Ridge Central and Lake Wales Ridge South) and one exhibits low to very low resiliency (Marion Uplands). Genetic diversity is lowest on the Mt. Dora Ridge, which exhibits very high resiliency (USFWS, 2023).

Threats and Stressors

Stressor:
Exposure:
Response:
Consequence:
Narrative: The modification and destruction of xeric upland communities in central Florida were primary considerations in listing the sand skink as threatened under the Act in 1987 (52 FR 42662). By some estimates, as much as 90 percent of the scrub ecosystem has already been lost to residential development and conversion to agriculture, primarily citrus groves (Florida Department of Natural Resources 1991, Kautz 1993). Xeric uplands remaining on private lands are especially vulnerable to destruction because of increasing residential and agricultural pressures. It is likely continued residential and agricultural development of xeric upland habitat in central Florida has destroyed or degraded habitat containing sand skinks. Approximately 60 to 90 percent of xeric upland communities historically used by sand skinks on the LWR are estimated to have been lost due to development (Christman 1988, Christman and Judd 1990, Kautz 1993, Center for Plant Conservation 1995). More recently, Turner et al. (2006) calculated 12.9 percent of this habitat remains.

Recovery

Reclassification Criteria:
Recovery Priority Number: 13

Recovery Actions:

- Protection of the sand skink from further habitat loss and degradation provides the most important means of ensuring its continued existence. Existing protection of occupied skink habitat consists primarily of private preserves such as ABS, Hendry Ranch, Tiger Creek

Preserve, and Saddle Blanket Lakes Scrub Preserve, coupled with publicly owned lands such as Lake Arbuckle State Park and State Forest, Lake Louisa State Park, and Highlands Hammock State Park (Service 1993a). Current efforts to expand the system of protected xeric upland communities on the LWR, coupled with implementation of effective land management practices, represent the most likely opportunity for assuring the sand skink's survival (Turner et al. 2006). It will also be important to preserve the genetic diversity of sand skinks by protecting sites in each of the four genetically distinct populations, from the MDR, the northern LWR, the central LWR, and the southern LWR. It is likely that a substantial sand skink population is present on existing private and public conservation lands on the LWR. As of 2003, about 21,597 acres (8,740 ha) of Florida scrub and high pine on the LWR have been protected, which represents almost half of the remaining xeric habitat on this ancient ridge, but only 6.3% of its estimated historic extent (Turner et al. 2006). Sand skinks are present on sites that total 87.4% of the currently protected xeric acreage (Turner et al. 2006), but many of the other conserved sites have not been surveyed adequately. Recovery of the sand skink also may require rehabilitation of suitable but unoccupied habitat or restoration of potentially suitable habitat. Because sand skinks do not readily disperse, introductions into restored or created unoccupied habitat may be necessary. Sand skinks relocated to two former citrus groves in Orange County have persisted for at least 5 years (Hill 1999, Mushinsky et al. 2001).

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES Recovery Activities 1. Acquisition, protection, and management of additional undeveloped scrub habitat, especially along the middle and southern central ridge of Florida. Land acquisition should be prioritized to purchase habitat congruent with existing protected and managed areas to obtain the best conservation value of the land for the species. This should be accomplished in coordination with acquisition of property across genetically distinct representative units. 2. Scrub preserves should be effectively designed and managed using a multi-scaled, multispecies approach based upon dispersal abilities, spatial requirements, and habitat needs of the species to be preserved (Hokit et al. 1999). 3. Habitat restoration and proper management techniques should be implemented on scrub and sandhill habitat. Exotic species removal should be continued, and prescribed burns in scrub habitat should be reinstated and/or continued. 4. Variability in the fire regime, including both seasonality and the fire return interval, should be considered and applied to management of the species and its habitat. 5. Partnerships should be promoted to share information, conduct collaborative research on scrub habitat conservation, and provide land managers and the interested public with information about the ecosystem, threats, recovery actions, and associated rare biota. 6. Genetic distinctions among sand skink populations throughout their range should be considered when conducting section 7 consultations, Habitat Conservation Plans, and recovery efforts and when planning reserve designs to maintain the genetic diversity of the species. 7. Nomenclatural changes should be made to officially designate the names of the species as Plestiodon reynoldsi. Monitoring / Research Activities 1. A range-wide survey of sand skinks should be completed to compare with the last one conducted in the early 1990s. A sampling design should be developed that can be used to monitor and assess skink population trends throughout their range on an annual basis. 2. Additional studies should be conducted on density, habitat, microhabitat conditions throughout the range of the species, and long-term demographic studies greater than 10 years are needed to discuss population trends. Aspects of natural history like dispersal and edge effects should also be studied. 3. Long-term studies should be undertaken on the effects of mechanical treatment and other management techniques. 4. Studies should be developed to understand the impact of climate change on sand skinks, their habitat, and prey base, and their capacity to adapt to changing conditions by altering their behavior and microhabitat use (USFWS, 2023).

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SPECIES ACCOUNT: *Thamnophis gigas* (Giant garter snake)

Species Taxonomic and Listing Information

Listing Status: Threatened; October 20, 1993 (58 FR 54053).

Physical Description

The giant garter snake (Thamnophis gigas) is one of the largest garter snakes, reaching an average total length of at least 162 centimeters (63.7 inches). They are olive to brown with a cream, yellow, or orange dorsal stripe and two light colored lateral stripes. They can also have a checkered pattern of black spots between the dorsal and lateral stripes. Individuals in the northern Sacramento Valley tend to be darker, with more pronounced mid-dorsal and lateral stripes. The ventral coloration is variable from cream to orange to olive brown to pale blue, with or without ventral markings. As giant garter snakes near skin shedding, all patterns and coloration may be obscured (USFWS 1999; USFWS 2012).

Taxonomy

The giant garter snake was first described as a subspecies of the northwestern garter snake (T. ordinoides). Since it was first listed, the taxonomic status of the giant garter snake has undergone several revisions, including its placements as a subspecies of the western terrestrial garter snake (T. elegans) and then the western aquatic garter snake (T. couchii). In 1987, the giant garter snake was accorded the status of a full species, T. gigas; since then, the taxonomy has not changed (58 FR 54053). The giant garter snake can be distinguished from the common garter snake (T. sirtalis) and the western terrestrial garter snake (T. elegans) by its color pattern, scale numbers, and head shape. Further biochemical, molecular, and morphological studies have demonstrated the giant garter snake’s distinction from other species in the western garter snake group (USFWS 1999).

Historical Range

Historically, giant garter snakes were found in boundaries of large flood basins, freshwater marshes, and tributary streams of the Central Valley (including Sacramento and San Joaquin valleys) of California. The giant garter snake’s historical range extends from the vicinity of Sacramento and Contra Costa counties southward to Buena Vista Lake near Bakersfield in Kern Country. The giant garter snake probably occurred from Butte County in the north and southward to Kern County. They historically inhabit natural wetlands and now occupy a variety of agricultural, managed, and natural wetlands (USFWS 1999; USFWS 2012).

Current Range

Currently, populations of the giant garter snake are found in the Sacramento Valley and isolated portions of the San Joaquin Valley; however, the species is extirpated from most of the San Joaquin Valley. Extant populations are distributed in portions of rice production zones of Sacramento, Sutter, Butte, Colusa, and Glenn counties, along with the western border of the Yolo Bypass in Yolo County, and along the eastern fringes of the Sacramento-San Joaquin Delta from the Laguna Creek-Elk Grove region of central Sacramento County southward to the Stockton area of San Joaquin County. As of 1992, there were 13 known populations, found at: (1) Butte Basin; (2) Colusa Basin; (3) Sutter Basin; (4) American Basin; (5) Yolo Basin-Willow Slough; (6) Yolo Basin-Liberty Farms; (7) Sacramento Basin; (8) Badger Creek-Willow Creek; (9) Caldoni Marsh; (10) East Stockton-Diverting Canal and Duck Creek; (11) North and South

Grasslands (probably extirpated); (12) Mendota (probably extirpated); and (13) Burrell-Lanare (probably extirpated). These population largely coincide with historical riverine flood basins and tributary streams. Populations 1 through 4 are associated with rice production zones; populations 5 through 13 mainly are in small, isolated patches of valley floor habitat (NatureServe 2015).

Distinct Population Segments Defined

No

Critical Habitat Designated

No;

Life History

Feeding Narrative

Adult: Giant garter snakes are carnivores, invertivores, and piscivores; they feed primarily on aquatic prey such as small fish, tadpoles, and frogs, which are distributed widely throughout their environments. Giant garter snakes can sometimes take advantage of small pools of water that may trap and concentrate prey items. It has been suggested the giant garter snake specializes in ambushing prey underwater, because it has been observed dragging its prey out of the water to be consumed. Giant garter snakes face some competition for resources from nonnative species. Giant garter snakes are mostly active during daylight hours; they are dormant or have low-activity from November to mid-March. They are fast growers; young giant garter snakes typically more than double in size in their first year. At birth, neonates immediately scatter into dense cover and absorb their yolk sacs, after which they begin foraging on their own (NatureServe 2015; USFWS 1999; USFWS 2015).

Reproduction Narrative

Adult: Male giant garter snakes are sexually mature at 3 years of age, and females are sexually mature at 5 years. The breeding season for giant garter snakes begins soon after emergence from overwintering sites. Males immediately begin searching for females after emerging from burrows. Breeding season is March through April, and females give birth from mid-July to early September. Giant garter snakes are viviparous; females brood internally and give birth to 10 to 46 young snakes, with an average litter size of 23. The sex ratio of giant garter snakes is 1:1.5 (females: males); however, sex ratios may differ with habitat quality and the neonate sex ratio has been observed as 1:1 (NatureServe 2015; USFWS 1999; USFWS 2012).

Geographic or Habitat Restraints or Barriers

Adult: Habitat loss throughout the range of the giant garter snake has resulted in fragmented and isolated habitat remnants (USFWS 2012).

Spatial Arrangements of the Population

Adult: Clumped according to resources.

Environmental Specificity

Adult: Community with all key requirements.

Tolerance Ranges/Thresholds

Adult: High

Site Fidelity

Adult: Moderate

Habitat Narrative

Adult: Giant garter snakes inhabit marshes, sloughs, ponds, small lakes, low-gradient streams, and other waterways and agricultural wetlands such as irrigation canals. Giant garter snakes appear to be most numerous in rice-growing regions. The diverse habitat elements of rice-lands contribute structure and complexity to this man-made ecosystem. Spring and summer flooding and the fall drying of rice fields coincide fairly closely with the biological needs of the species (USFWS 1999). In the summer, giant garter snakes are mostly likely found in aquatic habitats, typically in active rice fields and most often under aquatic vegetation cover (USFWS 2012). Giant garter snakes are absent from larger rivers and other water bodies that support introduced populations of large, predatory fish, and from wetlands with sand, gravel, or rock substrates (58 FR 54053). Giant garter snakes need enough water to provide food and cover during the active season from early spring through mid-fall. They also need emergent wetland plants such as cattails (Typha sp.) for coverage and foraging, and grassy banks and openings in vegetation for sunning. During the winter, when they are largely inactive, giant garter snakes need small mammal burrows and other crevices above flood elevations (USFWS 1999; USFWS 2012).

Dispersal/Migration

Motility/Mobility

Adult: Moderate

Migratory vs Non-migratory vs Seasonal Movements

Adult: Nonmigratory

Dispersal

Adult: Moderate

Immigration/Emigration

Adult: Unlikely

Dispersal/Migration Narrative

Adult: Giant garter snakes are nonmigratory. Habitat destruction and fragmentation have isolated populations, and limited dispersal. Gene flow appears to be restricted in the 13 isolated populations, which lends support for naming these basins as separate populations. In addition, the breeding of closely related individuals can cause a genetic reduction in fitness, inbreeding depression, and a loss of genetic diversity (USFWS 2012). There are some researchers, however, who believe that reports of small home ranges for giant garter snakes did not employ methods (e.g., radio telemetry) suitable for detecting full annual or multi-annual home range size, dispersal, or other long-distance movements, so these may have yielded underestimates of home ranges or activity areas (NatureServe 2015). During the breeding season, male giant garter snakes begin searching for females immediately after emerging from burrows (USFWS 2012).

Additional Life History Information

Adult: Habitat destruction and fragmentation has isolated populations, and limited dispersal (USFWS 2012).

Population Information and Trends

Population Trends:

Declining; (USFWS, 2020)

Species Trends:

Declining; (USFWS, 2020)

Population Growth Rate:

Slow decline

Number of Populations:

species is extant in 9 recovery Units (partially extant in Tulare Basin) (USFWS, 2020)

Population Size:

2,500 to 100,000 individuals (NatureServe 2015).

Resistance to Disease:

Moderate

Adaptability:

Moderate

Population Narrative:

Giant garter snakes have a population of 2,500 to 100,000 snakes throughout 13 known populations; however, two are presumed extirpated and three have been combined into a single population, leaving nine extant populations identified by surveys conducted in 2011. The populations are genetically different from each other, leading to a push to have distinct population segments. The short-term population-level trend of this species is a decline of 10 to 30 percent. The long-term population-level trend is a decline of 30 to 50 percent (NatureServe 2015; USFWS 2012). Recovery units are Butte Basin, Colusa Basin, Sutter Basin, American Basin, Yolo Basin, Cosumnes-Mokelumne Watershed, Delta Basin, San Joaquin Basin, Tulare Basin (extirpated south of Mendota) (USFWS, 2020)

Threats and Stressors

Stressor: Habitat destruction and urbanization
Exposure: Building of roads, expanding cities, water diversion, mosquito abatement.
Response: Mortality, reduced habitat.
Consequence: Reduction in population numbers.
Narrative: Urbanization and habitat destruction are the greatest threats to the giant garter snake throughout much of its range. Environmental impacts associated with urbanization are loss of habitat, reduction of wetland habitat, alteration of natural fire regimes, water diversion, fragmentation of habitat due to road construction, and degradation of habitat due to pollutants. Urbanization increasingly threatens the viability of giant garter snake populations as urban

landscapes encroach on ever-diminishing habitats. Habitat loss throughout the range of the giant garter snake has resulted in fragmented and isolated habitat remnants, compounded by the elimination of some rice agricultural land that serves as an alternative habitat for the species. Much of the remaining giant garter snake habitat is subject to flood control and canal maintenance activities, subjecting the snake to ongoing risks of mortality and injury. Maintenance activities may include weed eradication, which destroys surface cover; and rodent eradication, which indirectly eliminates the occurrence and abundance of underground burrows and retreats for giant garter snakes (58 FR 54053; USFWS 1999; USFWS 2012).

Stressor: Nonnative species
Exposure: Introduction of nonnative species.
Response: Mortality, competition, illness.
Consequence: Reduction in population numbers.
Narrative: Introduced nonnative plants may adversely affect the giant garter snake. For example, water primrose (Ludwigia peploides ssp. montevidensis) may concentrate giant garter snake prey in select pockets, and constrains movements of giant garter snakes. Any efforts to reduce the invasion of nonnative terrestrial plants may disturb or injure the giant garter snake if herbicides or mechanical removal is not compatible with giant garter snake requirements and behavior. Mechanical removal, mowing, or burning, for example, may result in direct injury or death to giant garter snakes if not conducted according to best management practices. Herbicides are suspected to reduce the prey base for the giant garter snake. Additionally, herbicides eliminate wetland plants, whose surfaces are colonized by algae, protozoa, rotifers, and other small organisms that serve as a food supply for amphibian larvae.Habitat degradation or alteration that benefits nonnative species may increase the vulnerability of giant garter snakes to predation. Introduced game and predatory fish such as largemouth bass (Micropterus salmoides) and catfish (Siluriformes) eat giant garter snakes. Adult bullfrogs (Lithobates catesbeianus), signal crayfish (Pacifastacus leniusculus), and the Louisiana crayfish (Procambarus clarkia) were also found to eat neonate giant garter snakes (58 FR 54053; USFWS 1999; USFWS 2012).

Stressor: Flooding and drought
Exposure: Floods or droughts.
Response: Mortality, reduced habitat.
Consequence: Reduction in population numbers.
Narrative: Although the giant garter snake is an aquatic species, it is subject to the detrimental effects of floods. Giant garter snakes may be displaced during a flood, buried by debris, exposed to predators, or subject to drowning when burrows and owerwintering sites become inundated with water. Drought is also a threat to giant garter snakes because of the species' dependence on permanent wetlands. Water availability will play a significant role in its survival and recovery. Emergent drought and higher temperature conditions are likely to result in high rates of mortality in the short term, with the effects of low fecundity and survivorship persisting after the drought has ceased (58 FR 54053; USFWS 1999; USFWS 2012).

Stressor: Climate Change (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative: Current climate predictions for California indicate that temperatures will increase and sea levels will rise (very high confidence), and that frequency of drought and intensity of heavy

precipitation events will increase (medium-high confidence) (Bedsworth et al. 2018). These effects may exacerbate known threats to the giant gartersnake, including habitat loss, floods, drought, and the spread of invasive species and diseases. (USFWS, 2020)

Stressor: Roads (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative: As discussed in the previous 5-year reviews, roads present a threat to giant gartersnakes both from direct mortality due to vehicle collision and fragmentation of habitat. Five of the 58 occurrences in the CNDDB reported since the 2012 5-year review are mortalities due to vehicular collision (CDFW 2019a). An assessment of road risk to reptiles and amphibians in California determined that the giant gartersnake was at very high risk of negative road impacts, primarily due to concerns with aquatic habitat connectivity (Brehme et al. 2018) (USFWS, 2020)

Stressor: Netting/Erosion Control Products (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative: As discussed in the previous 5-year reviews, netting and erosion control products can entangle and injure giant gartersnakes. However, the majority of construction projects that take place in the range of the giant gartersnake include BMPs which prevent the use of these materials. For example, the California Department of Transportation Construction Site BMP Manual states that plastic netting should not be used if there is a potential for endangering wildlife (Caltrans 2017). No reports of mortality due to netting or erosion control products has been reported to the SFWO since the 2012 5-year review. (USFWS, 2020)

Recovery

Reclassification Criteria:
Reclassification criteria are not identified in the Recovery Plan.

Recovery Priority Number: 2C

Delisting Criteria:
The sizes and densities at which giant garter snake populations occur are not well known. Population structure; population dynamics; and the strength, frequency, and direction of environmental fluctuation and effects are also largely unknown for giant garter snakes. Until uncertainties about these and other small population effects and their interactions are resolved, it is not possible to establish population numbers as a delisting criterion for the giant garter snakes. As an alternative, the first delisting criterion below for each recovery unit requires that subpopulations contain both adults and young. The U.S. Fish and Wildlife Service believes that if monitoring detects both adults and young in a given subpopulation, this suggests that the subpopulation is viable. To assist in establishing recovery criteria, the Central Valley is divided into four recovery units (USFWS 1999).

Sacramento Valley Recovery Unit: a. Monitoring shows that in 17 out of 20 years, 90 percent of the subpopulations in the recovery unit contain both adults and young, b. The three existing populations in the recovery unit are protected from threats that limit populations. c. Supporting habitat in the recovery unit is adaptively managed and monitored (USFWS 1999).

Mid-Valley Recovery unit a. Monitoring shows that in 17 out of 20 years, 90 percent of the subpopulations in the Recovery Unit (with the exception of the East Stockton-Diversifying Canal and Duck Creek population) contain both adults and young. b. The six existing populations in the recovery unit are protected from threats that limit these populations. c. Supporting habitat in the recovery unit is adaptively managed and monitored. d. Subpopulations are well connected by corridors or suitable habitat. e. Repatriation has been successful at all suitable sites that had recently (within last 10 years) extirpated populations (USFWS 1999).

San Joaquin Valley Recovery unit a. Monitoring shows that in 17 out of 20 years, 90 percent of the subpopulations in the recovery unit contain both adults and young, b. The six existing populations in the recovery unit are protected from threats that limit these populations. c. Supporting habitat in the recovery unit is adaptively managed and monitored. d. Subpopulations are well connected by corridors or suitable habitat. e. Recovery or repatriation has been successful at a total of five sites in the recovery unit. f. Giant garter snakes are broadly distributed in the North and South Grasslands and Mendota areas (USFWS 1999).

South Valley Unit a. Monitoring shows that in 17 out of 20 years, 90 percent of the subpopulations in the Tulare and Kern Basins contain both adults and young. b. Existing or reestablished populations in the recovery unit are protected from threats that limit populations c. Supporting habitat in the recovery unit is adaptively managed and monitored. d. Subpopulations are well connected by corridors of suitable habitat. e. Surveys for giant garter snakes are negative, and repatriation has been successful at four sites—two in the Kern (including Goose Lakes) Basin, and two in Tulare Basin (USFWS 1999).

The objective of this recovery plan is to reduce threats to and improve the population status of the giant garter snake sufficiently to warrant delisting. To achieve this goal we have defined the following objectives: 1. Establish and protect self-sustaining populations of the giant garter snake throughout the full ecological, geographical, and genetic range of the species. 2. Restore and conserve healthy Central Valley wetland ecosystems that function to support the giant garter snake and associated species and communities of conservation concern such as Central Valley waterfowl and shorebird populations. 3. Ameliorate or eliminate, to the extent possible, the threats that caused the species to be listed or are otherwise of concern, and any foreseeable future threats (USFWS, 2017).

Recovery Actions:

- Recovery criteria for the giant garter snake are defined for four recovery units in the Central Valley: the Sacramento Valley, Mid-Valley, San Joaquin Valley, and South Valley units. Recovery actions include:
- Protect known populations of the giant garter snake (USFWS 1999).
- Survey for new populations of giant garter snakes (USFWS 1999).
- Reestablish populations of giant garter snakes to suitable habitat within former range (USFWS 1999).
- Conduct necessary research on the giant garter snake (USFWS 1999).
- Develop and implement an outreach and education program (USFWS 1999).

- Develop and implement economic and other incentives for conservation and recovery on private lands (USFWS 1999).
- Actions Needed: 1. Protect existing habitat, areas identified for restoration or creation, and areas that will provide connectivity between preserved areas of habitat. 2. Develop and implement appropriate management of habitat on public and private wetlands and conservation lands. 3. Improve water quality in areas occupied by the giant garter snake and affected by poor water quality conditions. 4. Ensure summer water is available for wetland habitats used by the snake. 5. Establish an incentive or easement program(s) to encourage private landowners and local agencies to provide or maintain giant garter snake habitat. 6. Monitor populations and habitat to assess the success or failure of management activities and habitat protection efforts. 7. Conduct surveys and research to identify areas requiring protection and management. 8. Conduct research focused on the management needs of the species, and on identifying and removing threats. 9. Establish and implement outreach and education, which includes the participation of landowners; interested public and stakeholders; and other Federal, State, and local agencies. 10. Reestablish populations within the giant garter snake's historical range (USFWS, 2017).
- No grading, excavating, or filling may take place in or within 30 feet of giant garter snake habitat between October 1 and May 1 unless authorized by the California Department of Fish and Wildlife (CDFW) (previously California Department of Fish and Game) (USFWS 1999, Appendix C).
- Construction of replacement habitat may take place at any time of the year, but summer is preferred (USFWS 1999, Appendix C).
- Water may be diverted as soon as the new habitat is completed, but placement of dirt dams or other diversion structures in the existing habitat will require onsite approval by the CDFW (USFWS 1999, Appendix C).
- The new habitat will be revegetated with suitable plant species as directed by CDFW or as stipulated in the environmental documents (USFWS 1999, Appendix C).
- Dewatering of the existing habitat may begin any time after November 1, but must begin by April 1 (USFWS 1999, Appendix C).
- Any giant garter snake surveys required by the CDFW will be completed to the satisfaction of the CDFW prior to dewatering (USFWS 1999, Appendix C).
- All water must be removed from the existing habitat by April 15, or as soon as weather permits; the habitat must remain dry (no standing water) for 15 consecutive days after April 15 and prior to excavating or filling the dewatered habitat (USFWS 1999, Appendix C).
- CDFW will be notified when dewatering begins and when it is completed. CDFW will inspect the area to determine when the 15-day dry period may start (USFWS 1999, Appendix C).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR ACTIONS OVER THE NEXT 5 YEARS 1. Establish a Recovery Implementation Team to coordinate recovery efforts as identified in the Recovery Plan. 2. Secure additional habitat and water availability in the San Joaquin Valley in order to halt the continued decline of these populations. 3. Continue to study the abundance and distribution of the giant gartersnake in the Sacramento-San Joaquin Delta, including genetic analysis to be added to the existing genetic work. 4. Continue surveillance for the emerging Snake Fungal Disease and work to prevent this disease from affecting populations of the giant gartersnake, if required. 5. Evaluate the efficacy of eDNA sampling as a survey method for the giant gartersnake. (USFWS, 2020)

- The following three habitat components have been identified as the most important to the giant gartersnake (Service 2017): 1. A fresh-water aquatic component with protective emergent vegetative cover that will allow foraging; 2. An upland component near the aquatic habitat that can be used for thermoregulation and for summer shelter in burrows; and 3. An upland refugia component that will serve as winter hibernacula. (USFWS, 2020)

Additional Threshold Information:

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SPECIES ACCOUNT: *Stilosoma extenuatum* (Short-tailed snake)

Species Taxonomic and Listing Information

Listing Status: Proposed Threatened

Physical Description

The short-tailed snake is a slender snake (Figure 2 1) with an average length ranging from 31–53 centimeters (cm) (12–21 inches [in]) (Brown 1890, p. 199; Allen and Neill 1953, p. 8). Specimens range from 20–65 cm (8–29.5 in) (Woolfenden 1962, p. 649); these smallest specimens are juveniles and generally resemble adults (Allen and Neill 1953, p. 9; Rossi and Rossi 1993, p. 100). The cylindrical body is not distinct from the head, and the tail is notably short, averaging 10%of the body length (Brown 1890, p. 199; Highton 1956, p. 75). The dorsal color of short-tailed snakes is gray to silver with 50 to 80 dark brown to black lateral and dorsal blotches (Brown 1980, p. 199). Yellow to reddish pigment may occur between dorsal blotches (Krysko et al. 2019, pp. 473–475). The ventral surface is gray to brown with white spots and flecks (Brown 1890, p. 199). The defensive behavior and coloration of short-tailed snake may mimic that of other snake species including the pygmy rattlesnake (Sistrurus miliarius) (Enge et al. 2015, p. 451). The head of short-tailed snakes is dark; it may appear to have a triangular or Y-shaped mark with a yellow or orange crown (Ernst and Ernst 2003, p. 32), or be patterned with white flecks (Brown 1890, p. 200; Krysko et al. 2019, p. 473). A black post-orbital stripe is present on the head (Brown 1890, p. 200) (Figure 2 1). Other notable features include the presence of smooth teeth and scales; palatal teeth are present, but there is only a single anal scale (USFWS, 2021).

Taxonomy

The short-tailed snake was described as Stilosoma extenuata within a monotypic genus (Brown 1890, entire). The species epitaph was corrected to extenuatum by Cope (1982, p. 595). Three subspecies were described by Highton (1956, entire) based on fusion of head scales and the degree of blotchy coloration. Woolfenden (1962, p. 649) described variation in these characteristics which supported two subspecies within the western and eastern portions of the range, but subsequent accounts did not recognize subspecies (Highton 1976, p. 181.3). Genetic analysis has refined the taxonomy and phylogenetic relationships of the short-tailed snake. Stilosoma was grouped within kingsnakes (Lampropeltis) based on immunological distance data (Dowling and Maxson 1990, entire). Subsequent morphological work suggested Stilosoma could belong to a sister group to Lampropeltis (Keogh 1996, p. 406), but molecular analysis incorporating mitochondrial DNA (Rodriguez-Robles and de Jesus Escobar 1999, pp. 367–369; Bryson et al. 2007, p. 682) provided strong support for synonymizing Stilosoma with Lampropeltis (Pyron and Burbrink (2009, p. 528), and the specific epithet was changed from extenuatum back to its feminine form, extenuata, during this change. Subsequent genetic analysis has retained the classification of short-tailed snake within Lampropeltis (Ruane et al. 2014, p. 240), with this nomenclature well accepted. The genus is monophyletic, though the number of species has varied through time, ranging from 9 to 24 (Dahn et al. 2018, p. 220). There are currently 21 recognized species of Lampropeltis (Integrated Taxonomic Information System, 2017, unpaginated), of which the yellow-bellied kingsnake (Lampropeltis calligaster) and the larger and more widely distributed common kingsnake (L. getula) are closely related to the short-tailed snake (Bryson et al. 2007, p. 682, Ruane et al. 2014, p. 240). The current recommended standard name for L. extentuata is short-tailed kingsnake (Crother, 2017, p. 69) but the Service uses the more commonly used name, short-tailed snake (Krysko et al. 2019, p.

473–475). Although the taxonomy of the short-tailed snake has been revised since the species description, the current scientific name of Lampropeltis extenuata is recognized and is not in dispute or expected to change (USFWS, 2021).

Historical Range

The short-tailed snake is endemic to peninsular Florida. Fossil records of the short-tailed snake are known from the mid-Pliocene from the Florida peninsula (Auffenberg 1963, p. 209), indicating the species has inhabited the area since its apparent origin in the Pliocene (Dowling and Maxson 1990, p. 84; Ruane et al. 2004, p. 240; Pyron and Burbrink 2009, p. 528). The species primarily occurs in the central ridges of the Florida peninsula (Krysko et al. 2019, p. 473). However, the species has also been recorded from beyond the central ridges, farther west to the Gulf Coast from Levy County south to Hillsborough and Pinellas counties as well as farther north in Columbia County (Figure 2-2). Alachua County has the most historical (pre-2000) records; however, this apparent concentration of records is feasibly attributed to the presence of the University of Florida-associated herpetological community (Enge et al. 2016, p. 23). Historically (e.g., pre-2000), the species was documented within 17 Florida counties. The species has been documented within 11 of the 17 Florida counties since 2000: Gilchrist, Alachua, Putnam, Levy, Marion, Lake, Citrus, Hernando, Pasco, Hillsborough, and Polk (Figure 2 2). A total of 245 records (136 historical (all records before 2000) and 109 recent (2000–2021)) for the short-tailed snake were provided by Florida Fish and Wildlife Conservation Commission (FWC) (FWC 2020, unpaginated). New records (e.g., 2021) conveyed to the Service during the preparation of this report were manually added to this database; these very recent records are included in the summary of records presented here. There have been no systematic population surveys for the short-tailed snake. Effective survey methods for this cryptic, fossorial species have not been determined. As noted within the Species Action Plan for the Short-tailed Snake (FWC 2013, p. 12), better survey methods are needed to understand shifts in the species range and to evaluate population trends. The current and historical ranges for the species are generally agreed upon, but a failure to document the species in a given location and time period could be attributed to the low probability of detection of this fossorial species and may not represent true species absence (USFWS, 2021).

Current Range

The short-tailed snake is endemic to peninsular Florida. Fossil records of the short-tailed snake are known from the mid-Pliocene from the Florida peninsula (Auffenberg 1963, p. 209), indicating the species has inhabited the area since its apparent origin in the Pliocene (Dowling and Maxson 1990, p. 84; Ruane et al. 2004, p. 240; Pyron and Burbrink 2009, p. 528). The species primarily occurs in the central ridges of the Florida peninsula (Krysko et al. 2019, p. 473). However, the species has also been recorded from beyond the central ridges, farther west to the Gulf Coast from Levy County south to Hillsborough and Pinellas counties as well as farther north in Columbia County (Figure 2-2). Alachua County has the most historical (pre-2000) records; however, this apparent concentration of records is feasibly attributed to the presence of the University of Florida-associated herpetological community (Enge et al. 2016, p. 23). Historically (e.g., pre-2000), the species was documented within 17 Florida counties. The species has been documented within 11 of the 17 Florida counties since 2000: Gilchrist, Alachua, Putnam, Levy, Marion, Lake, Citrus, Hernando, Pasco, Hillsborough, and Polk (Figure 2 2). A total of 245 records (136 historical (all records before 2000) and 109 recent (2000–2021)) for the short-tailed snake were provided by Florida Fish and Wildlife Conservation Commission (FWC) (FWC 2020, unpaginated). New records (e.g., 2021) conveyed to the Service during the preparation of this report were manually added to this database; these very recent records are included in the summary of records presented here. There have been no systematic population surveys for the short-tailed snake. Effective survey methods for this cryptic, fossorial species have not been determined. As noted within the Species Action Plan for the Short-tailed Snake (FWC 2013, p. 12), better survey methods are needed to understand shifts in the species range and to evaluate population trends. The current and historical ranges for the species are generally agreed upon, but a failure to document the species in a given location and time period could be attributed to the low probability of detection of this fossorial species and may not represent true species absence (USFWS, 2021).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food/Nutrient Narrative

Adult: All snakes in the genus Lampropeltis are nonvenomous and are considered ophiophagous (to primarily consume other snakes) though other prey items such as lizards may also be consumed. Our understanding of the short-tailed snake diet is based almost entirely on observations of captive snakes. Prey may be killed by constriction as in other Lampropeltis species, but larger snake prey can escape even after two hours of constriction (Carr 1934, p. 139; Mushinsky 1984, p. 68; Rossi and Rossi 1993, p. 101). Short-tailed snakes predominantly consume small snakes, particularly Florida crowned snakes (Tantilla relicta) (Carr 1934, entire; Mushinsky 1984, entire; Rossi and Rossi 1993, entire). Florida crowned snakes are often hidden beneath leaf litter, logs, rocks, or other surface cover; they can occur even within suburban neighborhoods where development encroaches into favorable upland habitats (Florida Museum emm 2021, unpaginated). Five species of common, live-bearing snakes as well as skink species were consumed by a captive juvenile short-tailed snake, which may indicate broader food preferences in this life stage or in the species in general (Rossi and Rossi 1993, p. 101). Only Florida crowned snakes were selected during feeding trails with an adult male, though several other species were offered at least once (Mushinsky 1984, p. 68). Other notable prey items from snakes observed in the field include the Florida worm lizard (Rhineura floridana) (Dye et al. 2018, entire) and the nonnative Brahminy blind snake (Indotyphlops braminus) (Godley et al. 2008, p. 473). The importance of Florida worm lizards as a prey item may be significant, as this species can be common and is likely highly susceptible to predation by short-tailed snakes (Enge 2021a, pers. comm.). Florida worm lizards can inhabit both xeric and mesic upland habitats, often located just beneath a leaf-mold layer in well-drained sandy soil (USFWS, 2021)

Reproductive Strategy

Adult: Oviparity

Reproduction Narrative

Adult: Little information is available about short-tailed snake reproduction. Attempts to breed this species in captivity have been unsuccessful. The March–May period is presumably the breeding season as in many snakes, but courtship has never been observed (Enge 2014, p. 1). While access to mates could be a limiting factor in rare snakes, the ability to store sperm for later usage (e.g., months to years) occurs in many species (Lillywhite 2014, p. 195). Considering the high degree of surface activity in fall (Figure 2 5), it is possible short-tailed snakes can also breed during this period as well and store sperm over winter (Enge 2014, p. 6). Short-tailed snakes are presumed to lay eggs. Most colubrid snakes and all kingsnakes are oviparous (lay eggs) (Lillywhite 2014, p. 32). Female short-tailed snake specimens in the University of Florida Herpetology Collection were examined for the presence of eggs but none were found (Krysko et al. 2019, p. 474). In a recent study, a female short-tailed snake kept with two males did not appear gravid (pregnant) in May–July, when most oviparous snake species in Florida lay eggs (Enge 2014, p. 6). Environmental factors (e.g., temperature, sunlight, and rainfall) heavily influence when many snake species emerge from dormancy as well as lay eggs. Additionally, many snake species lay eggs yearly in temperate climates, provided that temperatures are not extreme, and resources are not severely limited (Lillywhite 2014, p. 200). Therefore, we may reasonably assume that short-tailed snakes produce eggs yearly, given suitable conditions. For many reptile species, the sex of offspring is determined by nest temperature, and it is unknown if short-tailed snake sex determination is temperature dependent as well. Short-tailed snakes apparently spend most of their lives beneath sandy soil and likely lay eggs underground (Ernst and Ernst 2003, p. 325). As an example of investigation into reproductive behavior of short-tailed snake, we describe one such effort. To facilitate egg-laying in captive short-tailed snakes, a depression was dug in one corner of the aquarium and filled with damp sphagnum moss; the substrate in the aquarium otherwise consisted of a 15-cm-thick intact section of soil and associated leaf litter from suitable habitat (Enge 2014, p. 3). Other fossorial species (eastern hognose snake) have been known to dig nests for eggs at roughly 15-cm depth (Edgren, 1955, pp. 105–108). It was noted that the female short-tailed snake spent a considerable amount of time buried in sand compared to the males (Enge 2014, p. 6). If the female mated, the follicles that produce eggs may have been reabsorbed due to inadequate nutrition or environmental conditions even in the presence of appropriate sites for oviposition (Enge 2014, p. 8). We are uncertain of the life span of the short-tailed snake and age at maturity. Juvenile short-tailed snakes have been documented, providing insight into the potential hatching period. A juvenile snake measuring 19 cm (6 in) snout-vent length and 21.5 cm (8.5 in) total length captured in mid-April retained its umbilical scar, implying the individual had hatched that spring or the previous fall (Rossi and Rossi 1993, p. 100). The body size of snakes at maturity is a relatively constant proportion of the maximum size (Shine and Charnov1992, p. 1257); therefore, short-tailed snakes <30 cm (12 in) total length are presumed to be immature (Enge 2014, p. 2). Generation length is defined as the average age of parents of the current cohort, which is greater than the age at first breeding and less than the age of the oldest breeding individual. No demographic data or longevity records are available for the species. However, the congeneric common kingsnake attains sexual maturity in 2–3 years and may live to be 25 years old in captivity (Robert et al. 2007, p. 396). However, the short-tailed snake may reach sexual maturity earlier because it occurs in a warmer climate (Florida). As with other small snake species, its smaller adult size may lead to higher predation rates and a shorter lifespan in the wild. Based on the information for the congeneric species and adjusted for climatic conditions, we infer a mean generation length of 6 years for the short-tailed snake (USFWS, 2021).

Habitat Type

Adult: Sandills

Habitat Narrative

Adult: Little is known about the habitat requirements of short-tailed snakes other than that inferred from occurrence data. The species is observed in a few xeric upland natural communities and their ecotones (transition areas), in association with well-drained sandy soils. Upland natural communities with short-tailed snake records include sandhills, scrub, and xeric hammock (Van Duyn 1939, p. 52; Carr 1940, pp. 14–15; Highton 1956, p. 93–94; Campbell and Chrisman 1982, p. 167; Enge et al. 2016, p. 16). Ecotonal areas that may support all or some of the needs of the short-tailed snake include scrubby flatwoods and mesic hammocks (Trescott 1998, p. 34). Scrubby flatwoods are associated with and often grade into scrub or sandhill communities (FNAI 201, pp. 47, 49). Mesic hammock may only be occupied within the context of fire suppression; over time, xeric hammocks that do not burn are eventually colonized by more mesic tree species, and short-tailed snake populations may persist in these hammocks (Enge 2021a, pers. comm.). These ecotonal or fire suppressed areas were included with the community types described in more detail below for the purposes of habitat suitability modeling (USFWS, 2021).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: For the short-tailed snake to persist as isolated populations within a previously more extensive and connected range, the degree of genetic exchange between populations is critical to reduce the risk of extinction from inbreeding and reduced capacity for evolutionary adaptation (Carlson et al. 2014, p. 523). Connectivity requires suitable habitat that is unfragmented by roads and is characterized by shorter and wider habitat corridors than those needed for more vagile animals (Breininger et al. 2012, p. 366) to allow for short-tailed snake's long-distance dispersal, contributing to the maintenance of gene flow across the range and long-term viability. A lack of periodic gene flow between populations can exacerbate impacts of various stressors and reduce the frequency of adaptive alleles (See Section 3.6 Small, Isolated Populations). Dispersal of individual short-tailed snakes is not well known, and long distance dispersal (greater than 5 km) is likely rare (Enge 2021, pers. comm.; Moler 2021, pers. comm.; Tupy 2021, pers. comm.). For the purposes of this SSA, we define population connectivity (or genetic connectivity) as the maximum distance an individual snake may reasonably be expected to disperse both within a unit and between units. Our analysis units are based on the concept of biological populations, but we have few species' occurrence records and therefore also rely on the presence of contiguous habitat to describe analysis units. The connectivity distance for this assessment is a 5-km buffer around short-tailed snake units; this corresponds to both the assumed dispersal distance, as well as long-distance dispersal beyond 5 km (up to 10 km) where units do not have a high degree of buffer overlap (USFWS, 2021).

Population Information and Trends

Resiliency:

Of the 49 analysis units assessed for current resiliency, we determined 8 units (16%) to be Likely Extirpated and 30 units (61%) exhibit Unknown resiliency. Of the remaining 11 analysis units with current resiliency fully analyzed, 1 unit exhibits Very low resiliency, and 4 units exhibit Low resiliency. Four analysis units exhibit Moderate resiliency, and 2 units exhibit High resiliency. Overall, if we do not consider analysis units for which we have no records (30 units with Unknown status), then 11 of remaining 19 units (58%) are extant. Eight units were determined to be extirpated, primarily due to loss of habitat. Of the 11 extant analysis units, we determined approximately half (54%) exhibit Moderate or High resiliency. Analysis units with High resiliency are found in the central portion of the species range (Units 1 and 3; Figure 4 2). Units determined to be Moderate resiliency are largely found between Units 1 and 3 (e.g., unit 8), as well as to the northwest of Units 1 and 3 (e.g., units 4,7, and 12). Units we consider Likely Extirpated are located towards the southeastern and southwestern portions of the range, on the periphery of the highest condition units. These Likely Extirpated units include several occurrence records in areas where habitat no longer exists, suggesting a significant range contraction. Low, Very low, and Unknown resiliency units are found at the periphery of the range to the south and north (USFWS, 2021).

Representation:

The short-tailed snake has a very limited geographic range and no information available regarding genetic variation within or among populations across the species' range. Genetic structuring is known to occur in other species endemic to the central ridges (e.g., the sand skink (Neoseps reynoldsi) [Branch et al. 2003, p. 206], sand cockroach (Arenivaga floridensis) [Lamb et al. 2018, pp. 5258–5259]), such genetic work is not available for the short-tailed snake. If further studies discover similar genetic structuring in the short-tailed snake or potential structure based on north-south or east-west connectivity, this genetic structuring may affect species-level representation. There is morphological variation in short-tailed snakes. The variation does not appear to conform to geographic or other boundaries and as such, there is no strong evidence to support delineating multiple representative units for this species at present, and the depiction of units based on morphology would be somewhat arbitrary given these features do not reliably support subspecies designations (USFWS, 2021).

Redundancy:

We determined the current short-tailed snake redundancy to be moderate; this redundancy is likely reduced from historical levels. Eight of the 19 analysis units with associated short-tailed snake records are likely extirpated (contain no records since 1972 and/or have little or no suitable habitat) (Table 4 5). This loss of analysis units is a reduction in redundancy and reflects a contraction of the range. In addition, 17 counties in Florida have species records before the year 2000, while11 counties have species records since 2000, representing a loss of occurrences or populations (Section 2.3 Range and Distribution). Four of the six analysis units in the high or moderate resiliency categories are clustered in the central portion of the species' range and make up a large extent of the range (Figure 4 2; Table 4 6). Two other analysis units with high or moderate resiliency are removed from the main cluster and represent the eastern and westernmost extent of the range. Of the 11 analysis units, 45% of the total analysis unit extent (area) exhibits high resiliency, 31% of the area has moderate resiliency, 23% has low resiliency, and 1% has very low resiliency (Figure 4 3). Thus, approximately 76% of the extant analysis unit area exhibits high or moderate current resiliency. However, uncertainty around the species' redundancy centers around the analysis units with no short-tailed snake occurrence records, but with suitable habitat (Unknown resiliency) that make up 30 of the 49 (61%) of the delineated analysis units across the species range. These units may represent errors or gaps in species knowledge (and not actually be habitat), they may be occupied, or they may be extirpated. Based on the actual condition of the analysis units in unknown resiliency, the short-tailed snake redundancy may be higher or lower than determined (USFWS, 2021).

Number of Populations:

Of the 49 analysis units assessed for current resiliency, we determined 8 units (16%) to be Likely Extirpated and 30 units (61%) exhibit Unknown resiliency. (USFWS, 2021)

Population Narrative:

49 total analysis units. 11 current, 8 likely extirpated, 30 unknown (USFWS, 2021).

Threats and Stressors

Stressor: habitat loss, degradation, and fragmentation (USFWS, 2021)
Exposure:
Response:
Consequence:
Narrative: The best available information regarding the short-tailed snake and short-tailed snake habitat indicates that habitat loss, degradation, and fragmentation due to land use changes from urbanization, agriculture, and mining are the most significant factors influencing short-tailed snake viability. Urbanization may be the main cause of habitat loss in the future. It brings road construction and expansion, which may cause direct mortality of short-tailed snake. In addition, urbanization may create conditions favorable to the establishment and spread of nonnative invasive species and may hinder prescribed fire activities in adjacent and nearby habitat. Certain habitat management practices may be incompatible with short-tailed snake needs and include absent or infrequent fire management, mechanical activities that disturb soil, and management objectives that favor heavy shrub layers, closed canopy conditions, or excessive leaf litter accumulations.

Recovery

Conservation Measures and Best Management Practices:

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Additional Threshold Information:

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References

USFWS. 2021. Species status assessment report for the short-tailed snake (Lampropeltis extenuata), Version 1.0. February 2022. Atlanta, GA.