SPECIES ACCOUNT: *Actinemys marmorata marmorata* (Northwestern pond turtle)

Species Taxonomic and Listing Information

Listing Status: Proposed Threatened

Physical Description

The western pond turtle is a medium-sized turtle (Figure 1). Size varies geographically, with the largest animals occurring in the northern part of the range (Holland 1994, pp. 2-3). The maximum carapace (shell) length (CL) of northwestern pond turtles is 241 millimeters (mm) (Lubcke and Wilson 2007, p. 110), and maximum CL of southwestern pond turtles in 179 mm (Germano and Riedle 2015, p. 104). Northwestern pond turtle adults typically range in size between 160 to 180 mm long and weigh between 500 to 700 grams (Bury et al. 2012, p. 4), while southwestern pond turtles range from 110 to 179 mm long and weigh between 194 to 828 grams (USFWS, 2023).

Taxonomy

Western pond turtles are currently identified as being in the family Emydidae; Class: Reptilia, Order: Testudines, Suborder: Cryptodira, and Superfamily: Testudinoidea. The species was first identified in 1852 as Emys marmorata from specimens collected from Puget Sound, Washington (Baird and Girard 1852, pp. 174–177). Past taxonomy for the western pond turtle is further detailed in Bury et al. (2012, pp. 1–3), including designation as species or subspecies; and classification in the genera Emys, Actinemys, or Clemmys. There has also been suggestion of three morphologically distinct groups (Holland 1994, p. 2-3) or four distinct clades based on genetic variation, with three occurring south of San Luis Obispo (Spinks and Shaffer 2005, entire). In recent publications, the genus name is interchanged between Emys and Actinemys with several authorities placing the two species in the more inclusive Emys or the more narrowly defined Actinemys (Stephens and Wiens 2003, p. 596; Fritz et al. 2011, entire; Spinks et al. 2016, entire; Turtle Taxonomy Working Group et al. 2017, pp. 75–76). Because the genus name is interchanged between Emys and Actinemys, the species names may be seen in both forms as well. Spinks et al. (2014, entire) recommended splitting the western pond turtle into two separate species, and this split was recognized in taxonomic lists in 2017 (Crother 2017, p. 82; Turtle Taxonomy Working Group et al. 2017, p. 76). The current authoritative list of the subject, the Turtle Taxonomy Working Group checklist, refers to the two species as northwestern pond turtle (Actinemys marmorata) and southwestern pond turtle (Actinemys pallida) (Turtle Taxonomy Working Group et al. 2021, pp. 171–172). Based on the recognition by the scientific community, and in following with the Society for the Study of Amphibians and Reptiles and the Turtle Taxonomy Working Group, the Service recognizes northwestern pond turtle and southwestern pond turtle as separate species. Some common names that are associated with western pond turtles are: Pacific pond turtle, Pacific mud turtle, Pacific terrapin, and western mud turtle (USFWS, 2023).

Historical Range

The historical range of western pond turtles extends along the Pacific coast from British Columbia, Canada to the northern part of Baja California, Mexico, primarily west of the Sierra Nevada and Cascade ranges (Ernst and Lovich 2009, p. 173; Stebbins and McGinnis 2018, p.

205). Western pond turtles have been found at sites from brackish estuarine waters at sea level up to 2,048 meters (m) (6,719 feet (ft) (Ernst and Lovich 2009, p. 176) but mostly occur below 1,371 m (4,980 ft.) (Stebbins and McGinnis 2018, p. 205). Several isolated populations occur, including but not limited to those in the vicinity of Puget Sound, Columbia Gorge, the Mojave River in California, and the Carson and Truckee Rivers in Nevada (Holland 1994, p. 2-4). . Historical accounts from Vancouver Island and mainland British Columbia, Canada in the lower Fraser River watershed may represent transplanted individuals; no reports of the species are known from either region since 1966 (Gregory and Cambell 1984 in Ernst and Lovich 2009, p. 173), and western pond turtles are considered extirpated from British Columbia, Canada (Ministry of Environment 2012, p. iv). Single records from southwestern Idaho and Grant County, Oregon (Nussbaum et al. 1983 in Ernst and Lovich 2009, p. 173) are likely introduced (Ernst and Lovich 2009, p. 173), and other isolated populations within the species' native range may also represent introductions (USFWS, 2023).

Current Range

The range of the northwestern pond turtle includes populations from the San Joaquin Valley north, all populations in California north of the middle of Monterey Bay, the Coastal and Cascade Ranges of Oregon and Washington State, and an outlying population in Nevada (USFWS, 2023).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Food Source

<u>Adult:</u> fish, tadpoles, and frogs. dragonfly larvae, mayflies, stoneflies, caddisflies, midges, beetles, and other insects, including terrestrial prey items (e.g., grasshoppers) (USFWS, 2023).

Food/Nutrient Narrative

<u>Juvenile:</u> Juveniles consumed mostly invertebrates (Bury 1986, p. 517), and hatchlings primarily feed on nekton and larvae of small aquatic insects (USFWS, 2023).

<u>Adult:</u> The western pond turtle is omnivorous and considered a dietary generalist (Holland 1994, p. 2- 5), consuming a wide variety of food items. Prey resources are primarily found within water but can be captured or scavenged on land. Food captured or scavenged on land must be brought back to water for consumption, as they appear to be unable to swallow in the air (Holland 1994, p. 2- 6). Animal matter appears to constitute a larger portion of the diet than plant material (Bury 1986, pp. 518–520; Holland 1994, pp. 2-5–2-6). Stomach contents reveal the diet consists of small aquatic invertebrates, with small vertebrates (fish, tadpoles, and frogs), carrion, and plant material (Bury 1986, p. 516; Holland 1994, pp. 2-5–2-6). In northern California, contents of 77 stomachs included aquatic insects such as dragonfly larvae, mayflies, stoneflies, caddisflies, midges, beetles, and other insects, including terrestrial prey items (e.g., grasshoppers) (Bury 1986, p. 516). Bury (1986, p. 517) found that 44 percent of the females consumed plant material compared to 10 percent of the males. Juveniles consumed mostly invertebrates (Bury 1986, p. 517), and hatchlings primarily feed on nekton and larvae of small

aquatic insects (USFWS, 2023).

Reproductive Strategy

Adult: Oviparity (USFWS, 2023)

Lifespan

Adult: The maximum lifespan of western pond turtles is unknown. However, they are long-lived species after reaching adulthood, with some living to at least 55 years of age (Bury et al. 2012, p. 17). These old individuals are rare in natural populations, but they appear to reproduce throughout their life span based on a radiograph of a 55 year old female with eggs (USFWS, 2023).

Breeding Season

Adult: Oviposition usually occurs from May through July, with northern populations depositing eggs later in the season than those in the south (USFWS, 2023)

Reproduction Narrative

Adult: The time from ovulation of eggs to oviposition in the nest is unknown. Oviposition usually occurs from May through July, with northern populations depositing eggs later in the season than those in the south (Bury et al. 2012, p. 15). Gravid female turtles generally leave the water in the late afternoon or early evening and move into upland habitats to excavate a nest (Holland 1994, p. 2-10). Females may be out of the water for a few hours to several days with nest completion taking anywhere from 2 to more than 10 hours. Females may make several forays into the upland prior to actual oviposition, and sometimes make false scrapes where they abandon the nest prior to laying eggs, potentially as a result of hitting rocks or roots or because of disturbance, which western pond turtles are extremely sensitive to (Holland 1994, p. 2-10; Bury and Germano 2008, p. 001.5). Females will moisten the soil around the nest by urinating prior to digging the nest chamber (Holland 1994, p. 2-10; Hays et al. 1999, p. 12). Females excavate nests 3 m to 500 m from water in compact, dry soils (Storer 1930, p. 434; Holland 1994, p. 2-10; Holte 1998, p. 54), with an average linear distance from water of 51 m (Davidson and Alvarez 2020, p. 44). Localized soil conditions, as well as the frequency and degree of disturbance in the upland habitat, probably limit nest distribution (Thomson et al. 2016, p. 300). Soils need to be loose enough to allow nest excavation, and typically have a high clay or silt component. Disturbance needs to be infrequent enough or of sufficiently low intensity that nesting females are not disturbed (Ernst and Lovich 2009, p. 178). Nests are shallow and generally occur between 9 to 12 cm below the surface (Holland 1994, p. 2-10). After the nest is excavated and eggs deposited, females pack the chamber using surrounding material such as mud, dry soil, and vegetation to form a plug that closes off the neck of the nest chambe Western pond turtles exhibit temperature-dependent sex determination (TSD) during incubation (Ewert et al. 1994, p. 7). In California, female hatchlings were more likely when 30 percent of the sex-determining period occurred above 29° Celsius (C) (84° Fahrenheit (F)) (Christie and Geist 2017, p. 49). In addition, lower fluctuations in temperature resulted in development of males, whereas females developed in nests with high and low temperature fluctuations. Temperatures within nests were found to fluctuate daily, varying by more than 20°C (36°F) on a daily basis (Geist et al. 2015, p. 498; Christie and Geist 2017, p. 50). Higher maximum temperatures reduce overall egg viability (USFWS, 2023).

Habitat Type

Adult: Semi-aquatic (USFWS, 2023)

Habitat Vegetation or Surface Water Classification

Adult: Streams/ponds/reservoirs/marshes/estuaries (USFWS, 2023)

Spatial Arrangements of the Population

Adult: Clumped

Environmental Specificity

Adult: High

Site Fidelity

Adult: Moderate

Habitat Narrative

Juvenile: Hatchlings While few studies have tracked hatchlings leaving the nest, available studies show variation in timing of emergence and behavior post-emergence. In southern and central California, some hatchlings may emerge from the nest chamber in late-summer to early-fall, whereas others overwinter in the nest chamber and emerge in spring (Holland 1994, p. 2-10). In the northern parts of the range, hatchlings overwinter in the nest (Holland 1994, p. 2-10; Reese and Welsh Jr 1997, p. 354). In western Oregon, hatchlings delayed emergence until spring, and typically remained within 2 m of nests for as long as 59 days after initial emergence (Rosenberg and Swift 2013, entire). During migration from their nests to aquatic habitat, hatchlings embedded themselves in soil for up to 22 days at stop-over sites. Hatchlings entered aquatic habitat on average 49 days after initial emergence and traveled an average of 89 m from their nest site. Hatchlings detected in water were always within 1 m of shore and in areas with dense submerged vegetation and woody debris (Rosenberg and Swift 2013, entire). Growth Hatchlings can nearly double in size by the end of the first year (Germano and Rathbun 2008, p. 189; Germano 2010, p. 95; Bury et al. 2012, p. 17). Growth rates vary based on factors including developmental conditions, environmental conditions, geography, and individual variation (Bury et al. 2012, p. 16). For example, Holland (1994, p. 2-11) notes that turtles between 100 to 110 mm are generally 4 to 5 years old, but may be as young as 3 or as old as 12. Northwestern pond turtles in Oregon were slightly larger than the same species in California, although the growth rate to achieve these sizes was slower, possibly because of cooler temperatures. Age and size reached at sexual maturity is poorly understood and varies between sites and geography (Holland 1994, pp. 2-9, 5-2; Rosenberg et al. 2009, p. 22; Bury et al. 2012, p. 15). In general, males tend to exhibit external signs of sexual dimorphism around 110 to 120 mm CL (Bury et al. 2012, p. 15). In coastal central California, the average male reached 120 mm CL in 3.6 years compared to 4.1 years for females, and reached 150 mm CL in 8.3 years for males versus 11.1 years for females (Germano and Rathbun 2008, pp. 190–191). In Washington, males are thought to achieve sexual maturity when they are at least 10 to 12 years old (USFWS, 2023).

Adult: Western pond turtles are semi-aquatic, requiring both aquatic and terrestrial habitats that are within close proximity and connected to one another (Figure 7). As habitat generalists, western pond turtles occur in a broad range of permanent and ephemeral aquatic water bodies from remote to urban landscapes, including flowing rivers and streams, lakes, ponds, reservoirs, settling ponds, marshes, vernal pools irrigation ditches, and other wetlands, including some with estuaries with tidal influence (Spinks et al. 2003, entire; Bury and Germano 2008, p. 001.3; Ernst and Lovich 2009, p. 175; Bury et al. 2012, p. 12; Stebbins and McGinnis 2018, p. 205). Despite their ability to use a wide range of aquatic features, suitable aquatic habitats are relatively rare across much of the range, exacerbated by land use changes (e.g., urbanization and agriculture) after European settlement (discussed more in Chapter 8.1: Habitat Loss and Fragmentation). Consequently, the species' distribution may be disjunct across the landscape, following the arrangement of ponds or streams, especially in areas with extensive open, dry terrain between waterways (Bury et al. 2012, p. 12). The back-and-forth movements between aquatic and terrestrial habitats (i.e., migration) are typically less than 500 m (Reese and Welsh Jr 1997, p. 357), thus the two habitat types must be adjacent. In a study in northern California, radio-tagged males used terrestrial habitat in at least ten months of the year, emphasizing the importance of upland habitat in addition to aquatic habitat (USFWS, 2023).

Dispersal/Migration

Motility/Mobility

Adult: High

Dispersal

Adult: Moderate. Genetic analyses suggest that most movements occur within drainages (Spinks and Shaffer 2005, p. 2057), but few accounts of adult and juvenile dispersal exist. Within aquatic habitat, a dispersal distance of 7 km upstream was observed (5 km overland distance) (Holland 1994, p. 7-28). Dispersal may also occur via aquatic habitats during flood events (USFWS, 2023).

Dispersal/Migration Narrative

Adult: Migration: We define migration for the western pond turtle to be intra-population (within local populations) movements occurring between aquatic and upland environments. Migrations are often roundtrip and reoccurring (often seasonally, but not always annually), such as when individuals are moving from aquatic to upland environment (and back) for the purpose of nesting, overwintering, and aestivation. Males generally move farther than females or juveniles (Bury 1972a, pp. 65–66). Measured home ranges of western pond turtles average 1 hectare (2.5 acres) for males, 0.3 hectare (0.7 acre) for females, and 0.4 hectare (1 acre) for juveniles (Bury 1972a). Overwintering behavior is variable, and likely more common in seasonally inundated ponds than permanent water (Pilliod et al. 2013, p. 216). Using radio-telemetry, Holland (1994, pp. 6-12–6- 13) found overwintering sites at two streams/rivers that ranged from 15 to 260 m away from the aquatic environment. In northern California along the Trinity River, some turtles sought upland refuge to either overwinter or aestivate while others moved to lentic bodies of water (standing bodies of water) as far as 500 m from the river (Reese and Welsh Jr 1997, p. 356). The pattern and frequency of these migrations vary with habitat, size of the aquatic system, suitability of upland habitat, season, climate, environmental stress (e.g., drought, high stream flow), sex, and life stage (Hallock et al. 2017, p. 4). In central California, radio-tagged turtles spent over half of the year in terrestrial habitat, moving from 255 to 1,096 m over the study period but never moving farther than 343 m from seasonal ponds. Western pond turtles moved in different directions, used different microhabitats, and left ponds at different times. Dispersal: Dispersal of western pond turtles between populations/watersheds is generally not well understood. Genetic analyses suggest that most movements occur within drainages (Spinks and Shaffer 2005, p. 2057), but few accounts of adult and juvenile dispersal exist. Within aquatic habitat, a dispersal distance of 7 km upstream was observed (5 km overland distance) (Holland 1994, p. 7-28). Dispersal may also occur via aquatic habitats during flood events (Rosenberg et al. 2009, p. 21). Along the central California coast, Holland (1994, p. 2-9) recorded less than 10 dispersal events between drainages during a 10-year study with over 2,100 captures and recaptures across 21 drainages, suggesting that overland movements are uncommon. In that study, the longest overland distance recorded in an area considered to be under the best circumstances (mild climate and short distances between water features), was a single individual travelling 5 km. Holland (1994, p. 2-9), also states that no movements between drainages were detected from three other sites with over 1,100 hundred captures and recaptures over a 7-year period. During an extreme drought, Purcell et al. (2017, pp. 21, 24) documented a 2.6 km straight-line distance movement overland in a radio-tagged turtle, with a minimum total distance of 3.3 km moved before the individual found water (USFWS, 2023).

Population Information and Trends

Population Trends:

In Oregon, Nevada, and California within all of the analysis units, population growth rate and abundance for the northwestern pond turtle are currently declining (88 FR 68385).

Resiliency:

In Washington, as discussed above, the northwestern pond turtle is heavily reliant on implementation of conservation measures and is expected to depend on headstarting, bullfrog control, and habitat management into the future (Hallock et al. 2017, p. 14). Population modeling efforts looking out approximately 100 years (year 2112) found that populations declined towards extirpation in the absence of headstarting and management (Pramuk et al. 2013, pp. 28–29). Declines in populations were tied to both adult and hatchling mortality rates, with bullfrog removal positively influencing population persistence (Service 2023, pp. 101–102). Small populations were shown in the model to persist in the future without headstarting as long as adult mortality is relatively low and hatchling mortality is reduced through habitat management and predator control (Pramuk et al. 2013, pp. 29 and 32). The current adult mortality rate is unknown and hatchling mortality is estimated to be high (above 85 percent). Because the northwestern pond turtle is a State endangered species and recovery goals for down and delisting have not been met, the WDFW is committed to continuing the conservation measures of headstarting, conducting habitat management efforts, investigating and managing shell disease, and implementing predator control for the species to increase adult and hatchling survival (Anderson 2022, entire; Bergh and Wickhem 2022, p. 13; Hallock 2022, entire). However, without the continuance of current management (i.e., headstarting, predator control, and ongoing habitat management), we consider the northwestern pond turtle's resiliency in Washington to be in decline and question the ability of the species to withstand stochastic events in the future. In the Oregon, Nevada, and California analysis units, we used the modeling efforts to inform resiliency into the future. Looking at conditions of the northwestern pond turtle in the 50–75 year timeframe, by the year 2075 (approximately the next 50 years), the modeling efforts identified some declines in population size for the species with the probabilities of extirpation of the analysis units ranging from 30 percent in AU–6 along the Oregon coast to 43 percent in AU–14 in the San Joaquin Valley and San Francisco Bay area in California under scenario 1 (RCP 8.5/SSP 5) and 29 percent in AU–5 in the Willamette Valley unit in Oregon to 42 percent in AU–14 under scenario 2 (RCP 4.5/SSP 2). By the year 2100 (approximately next 75 years), the probabilities of extirpation of populations in analysis units ranged from 46 percent in AU–10 in the Northern California unit to 59 percent in AU–14 under scenario 1 (RCP 8.5/SSP 5) and 47 percent in AU–11 to 59 percent in AU–14 under scenario 2

(Service 2023, pp. 101–105). These predicted results of extirpation at the end of the 75-year timeframe (year 2100) will most likely cause declines in all analysis units with some populations within the analysis units to become functionally extirpated and limit the ability of smaller populations or populations in fragmented habitats to respond to stochastic events and limit the population resiliency in those units. Table 2 below identifies the range of the probability of extirpation (highest and lowest percentage) of analysis units for the northwestern pond turtle in 2050, 2075, and 2100. We consider the northwestern pond turtle's resiliency in Oregon, Nevada, and California will decline from current levels such that the species will be less able to withstand stochastic events in the future because of the fragmented nature of habitat and increased threat from anthropogenic impacts, predation from nonnative bullfrogs, and the effects of climate change from drought. Therefore, looking at the overall resiliency of the northwestern pond turtle across its range, we have determined that the species' resiliency will decline across the majority of its range in the next 50–75 year timeframe (88 FR 68386).

Representation:

For current representation, the species exhibits ecological flexibility in habitat use, particularly different types of waterbodies and ecological conditions from the Pacific Northwest in Oregon to northern and central California and eastern Sierra Nevada in Nevada. Based on genetic analyses, the northwestern pond turtle in Oregon and northern California has lower genetic variation than those further south, despite covering a larger geographic area. Although genetic variation is lower in the northern portions of its range, researchers suggest this is due to a more relatively recent (on a geologic timescale, after the retreat of Pleistocene glaciation in the last ~15,000 years) range expansion rather than a reduction in available genetic make-up (Shaffer and Scott 2022, p. 6). In addition, based on the number and distribution of populations and modeling efforts on persistence to the year 2050 (Gregory and McGowan 2023, entire; Service 2023, Appendix A), we do not expect severe population declines or extirpations in the near-term across Washington, Oregon, Nevada, and California analysis units; therefore the species is likely to maintain its ability to adapt to changing environmental conditions in the near-term and currently has sufficient representation. Northwestern Pond Turtle—Future Condition In the future, impacts from land conversion, bullfrog predation, and increasing drought will continue throughout the 50- to 75-year timeframe (to the year 2100) we considered in our analysis. The level of impact on the northwestern pond turtle associated with these threats generally follows a latitudinal trend, with the southern analysis units having a more negative response and therefore poorer condition than the more northern analysis units (88 FR 68386).

Redundancy:

The northwestern pond turtle has been subject to historical habitat loss, alteration, and fragmentation and is still impacted by the legacy effects from such habitat impacts (Rosenberg et al. 2009, p. 40). Nonnative predators, such as bullfrogs and largemouth bass, are also a threat to northwestern pond turtles (Rosenberg et al. 2009, pp. 40–47; Manzo et al. 2021, p. 492). Based on standardized occupancy surveys that were conducted in 2018–2020 at 138 historical sites and 176 new sites in Oregon, the current occupancy information appears to indicate that there are fewer occupied areas when compared to historical information (Samara Group, LLC 2021, entire). However, the existing habitat availability and connectivity, population distribution, and size of some populations would help maintain the species in Oregon. In California, the most significant declines have occurred in the southern portion of its range and is associated with habitat loss, urbanization, and historical overutilization (Jennings et al. 1992, pp. 10–11; Jennings and Hayes 1994, pp. 101–102; Kelly et al. 2005, pp. 63, 70; Bury and Germano

2008, p. 001.6; Bettelheim and Wong 2022, pp. 7–12). According to modeling efforts and other status assessments, the parts of the species' range in Oregon and northern California currently are less likely to be subject to the extensive habitat losses that have occurred further south and still have numerous well distributed and well connected populations in this area (Thomson et al. 2016, p. 301; Gregory and McGowan 2023, entire; Service 2023, Appendix A). For the species' southern parts of its range in central California, the species has a higher probability of extirpation than the populations in Oregon and northern California; however, numerous populations with evidence of breeding do still occur in areas such as Merced, Fresno and Kern Counties and would also provide some level of redundancy as these areas are associated with permanent natural and artificially ponded habitats that are currently protected or maintained (Germano 2010, pp. 91–96; Gregory and McGowan 2023, entire; Service 2023, Appendix A). In terms of current redundancy, the northwestern pond turtle is currently distributed across the analysis units in Washington, Oregon, Nevada, and California similarly to its historical distribution, with the majority of populations in northern California and Oregon. This spatial spread would most likely protect the species from catastrophic events including wildfire, flooding events, and severe drought. As a result, the species would most likely continue to maintain its ability to withstand catastrophic events, particularly in the center of the range (Oregon and Northern California) due to this extensive distribution. Based on this information, we consider the northwestern pond turtle in Oregon, Nevada, and California to currently have sufficient redundancy (88 FR 68386).

Threats and Stressors

Stressor: Altered Hydrology (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Aquatic resources used by the western pond turtle have experienced high levels of loss, alteration, and degradation throughout the range of the two species (Reese and Welsh Jr. 1998b, p. 505; Germano 2010, p. 89). A substantial portion of the losses of aquatic habitat are due to anthropogenic water use (e.g., dams and diversions for the purposes of providing water for human use). Moreover, within the historical range of the western pond turtle, an extensive system of hydrologic infrastructure, including dams, reservoirs, diversions, and aqueducts, supports extensive agricultural and municipal water uses, and provides domestic water to many densely populated areas (Lund et al. 2007, p. 43; Hanak et al. 2011, pp. 19–69). These alterations include stream channelization, altered flow regimes, groundwater pumping, water diversions, damming, and water regulation for flood risk management (flood control), which affect hydrology, thermal conditions, and structure of western pond turtle aquatic and upland habitat. More recently, rapid expansion of marijuana agriculture in the western United States is associated with extensive water use. Marijuana farms are slightly closer to streams and rivers than available private parcels (Parker-Shames et al. 2022, pp. 9–11), which has potential implications to freshwater species such as the western pond turtle. Water diversions for marijuana cultivation have decreased stream flow in some areas in Northern California with negative impacts to sensitive fish and amphibians species (Bauer et al. 2015, entire), although we are not aware of specific studies on impacts to western pond turtles. Altogether, hydrologic alterations have contributed to loss of habitat for the species, which is incorporated in the above section, and can have long-lasting impacts in areas where habitat does remain (USFWS, 2023).

Stressor: Recreation (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Recreational activities such as hiking, biking, fishing, boating, and off-highway vehicles, and the associated disturbance within or adjacent to aquatic and nest habitats, can affect western pond turtles in a variety of ways, depending on the region and type of recreation. Some forms of recreation may cause mortality of individuals through trampling, while others degrade habitat, disturb pond turtle behavior, and/or contribute to other threats. For example, recreational activities may interact with the threat of collection because humans may encounter the species while engaging in other activities. Western pond turtles are extremely wary and will rapidly flee from basking sites into the water when disturbed by the sight or sound of people at distances of greater than 100 m (328 ft) (Bury and Germano 2008, p. 001.5). Western pond turtles at the University of California, Davis, Arboretum were more abundant in basking sites that were farther from human paths, presumably to avoid human disturbance (Lambert et al. 2013, p. 196). In another example, human activity associated with trail use and an adjacent levee road near Moffett Federal Airfield in the San Francisco Bay Area decreased emergent basking by western pond turtles, although in this case there was a higher rate of disturbance associated with vehicular use on the adjacent levee than for trail use by runners, walkers, and bicyclists (Nyhof and Trulio 2015, p. 183). Whether the disturbance is by vehicles or humans, reducing the amount of time performing this behavior has potential effects on metabolism, proper digestion, feeding, reproduction, growth, and predator avoidance (USFWS, 2023).

Stressor: Predation (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Western pond turtles are impacted by both nonnative and native predators. Nonnative predators include American bullfrogs (Lithobates catesbeianus; hereafter bullfrogs) and invasive fish, such as large and smallmouth bass (Micropterus sp.; hereafter bass). Native predators of western pond turtles include raccoons, skunks, foxes, coyotes. mink, herons, river otters, burrowing small mammals, and giant water bugs (USFWS, 2023).

Stressor: Nonnative Species Competition (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Competition with nonnative species may be a threat to the western pond turtle, particularly when resources are otherwise limited, such as basking sites and/or prey items. The red-eared slider has been identified as the main potential competitor for western pond turtles, but direct evidence of competition is limited.   Red-eared sliders are listed as one of the “world’s worst invasive species” by the International Union for Conservation of Nature (IUCN) (Lowe et al. 2000, p. 6). They are common in areas near dense human populations, with red-eared slider numbers likely reinforced by releases or escapes of pets (Thomson et al. 2010, p. 300; Lambert et al. 2013, p. 196). Because red-eared sliders are often found in habitat heavily degraded by human activities, identifying the negative impacts from red-eared sliders versus effects from other coexisting threats can be difficult, especially in complex environments (Dupuis-Desormeaux et al. 2022, pp. 2–3). However, redeared sliders have been tied to declines in Sonora mud turtles

(Kinosternon sonoriense) because of interference for basking sites in a before-after study in an undisturbed natural environment (Drost et al. 2021, entire). Under experimental conditions, red-eared sliders negatively impacted weight and survival of European pond turtles (Emys orbicularis) (Cadi and Joly 2004, pp. 2514– 2515) and negatively impacted basking activity for Spanish terrapins (Mauremys leprosa) (USFWS, 2023).

Stressor: Disease (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Disease has been and is an emerging concern for western pond turtle populations. Documented diseases in western pond turtles include respiratory disease and shell disease. In 1990, an unidentified pathogen causing an upper respiratory disease killed more than a third (at least 36 individuals) of the extant western pond turtles in Washington at that time (Hays et al. 1999, p. 14; Hallock et al. 2017, p. 9). Additional cases of respiratory disease have not been detected in Washington, but two cases were documented in Oregon (B. Bury, pers. comm. in Hallock et al. 2017, p. 9). Pathogen sampling in western pond turtles in California detected Mycoplasma species (a type of bacteria) in northern, central, and southern California turtles, with infected turtles having lower body weights. They did not find evidence that sympatry with nonnative redeared sliders correlated with pathogen occurrence (Silbernagel et al. 2013, pp. 41–43). We are also aware of leeches, including in the genus Hellodelba and the introduced Placobdella parasitica, that have been reported on western pond turtles (S. Barnes 2023, in litteris; D. Ashton 2023, in litteris), but the ecology between these leeches and western pond turtles is poorly understood and is not discussed further in this report. For the remainder of this section, we focus on shell disease (USFWS, 2023).

Stressor: Road Impacts (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Although roads are tightly linked to urbanization and development, roadways also exist as a standalone threat since their presence is not always associated with urban or developed areas. Thus, we address roadways independently but also consider that the effects are synergistic with urbanization. Roads can affect western pond turtle viability because of vehicles killing or injuring individuals or disturbing basking behavior, and by reducing connectivity between populations, which reduces migration between upland and aquatic habitat (Rosenberg et al. 2009, p. 41; Nyhof 2013, p. 43; Thomson et al. 2016, p. 301; Nicholson et al. 2020, entire; Manzo et al. 2021, p. 494, S1 text supplement). Railroad tracks can also serve as barriers to migration, as is observed in other turtle/tortoise species (Rautsaw et al. 2018, pp. 138–139). There have been no documented western pond turtle population extirpations attributed directly to roadways. Additional threats that have associated affects with roads include: increased fragmentation (roads further break up the landscape), recreation (roads increase access to habitat), collection (roads increase access for humans), contamination (runoff of contaminants), and predation (roads increase access for predators), and an interaction with drought (drought causes turtles to spend more time in upland habitat, increasing potential to interact with roads). Despite the high likelihood that these threats have compounding impacts, there is limited direct evidence in the literature about their combined effects on western pond turtle. Many direct mortality events have been documented on roads, but these effects have mostly been

documented at the individual rather than the population level. Although roads are known to create dispersal barriers, there are no formal assessments of the impact of roads on connectivity of western pond turtles at the population level. Thus, it is difficult to assess the impact of roads on population-level parameters. However, in a road risk assessment ranking susceptibility of California herpetofauna to road mortality and habitat fragmentation, Brehme et al. (2018, p. 921) classified northwestern pond turtles and southwestern pond turtles as very high risk (both in the top 10 out of 160 species evaluated) (USFWS, 2023).

Stressor: Collection (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Collection of western pond turtles directly removes individuals from a population and can lead to reduced reproduction and recruitment. This is especially the case in populations that are fragmented or where numbers of individuals are already low. Extensive collection is widely reported along with habitat alteration and habitat loss (discussed above) as primary factors initially responsible for declines of both species (Holland 1994, p. 2-13; Hays et al. 1999, p. 16; Bettelheim 2005, entire; Rosenberg et al. 2009, p. 42; Thomson et al. 2016, p. 301). The true extent of these declines associated with collection remains largely unknown. However, Bettelheim (2005, entire) and Bettelheim and Wong (2022, entire) provide a thorough review of collection for commercial harvest occurring between the mid to late 1800s and early 1900s. At the height of collection in 1895, approximately 63,000 individuals from the San Francisco Bay area and Central Valley of California were marketed (Bettelheim and Wong 2022, p. 9). This was followed by approximately 53,935 individuals marketed for several years until the turn of the century from San Joaquin, Solano, Sonoma, Stanislaus, and Contra Costa Counties for the commercial terrapin fishery in California (Bettelheim 2005, p. 32; Bettelheim and Wong 2022, p. 9). Numbers in the thousands from several counties throughout California accounted for turtles collected for the San Francisco market with large numbers coming from the Sacramento and San Joaquin regions (Bettelheim 2005, pp. 32–33). In 1883, one trapper on Tulare Lake collected a minimum of 3,600 individuals. In 1904, not accounting for other collections during that time, an estimated 12,740 individuals were collected from San Joaquin and Sacramento Counties (Bettelheim 2005, pp. 32–33). Bettelheim and Wong (2022, p. 10) suggest that historic collection between 1863 and 1931 resulted in the collection of approximately 524,100 individuals and could be over a million individuals (Bettelheim and Wong 2022, p. 10) collected for the San Francisco market, and likely other markets in California, Oregon, and Washington (Holland 1991, p. 44). Collecting for commercial harvest likely had an impact on turtle populations by removing a greater number of reproductively viable adults and, consequently, acted as an intense population suppressant (USFWS, 2023).

Stressor: Toxins (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Although western pond turtles are exposed to a variety of toxins throughout their range, sensitivity of individuals to pesticides, heavy metals, pollutants, and other contaminants is largely unknown. However, contaminants in general have been identified as a significant threat in freshwater ecosystems both through indirect or through direct toxicity to organisms (Reid et al. 2019, p. 9). Potential affects to long-lived species such as the western pond turtle are

discussed in Rowe (2008, entire). For example, because western pond turtles take multiple years to reach reproductive maturity (see Chapter 5.0 Life History), potential effects from contaminants include mortality before reproduction, or chronic accumulation of contaminants that could be transferred to offspring (Rowe 2008, p. 626). Sources of contaminants affecting western pond turtles include run-off or drift from agricultural activities, run-off from mining sites, diesel spills, run-off from urbanized areas, and roadways. Pesticides and mercury are the most studied contaminants, but little to nothing is known about the biological implications. For example, variable amounts of organochlorine pesticides, polychlorinated biphenyls (PCBs), and mercury were detected in western pond turtle eggs at a site in Oregon, but differences in concentrations of these contaminants were not related to egg hatchability in the study (Henny et al. 2003, pp. 49–51). Contaminants can be toxic to aquatic prey items of western pond turtle such as amphibians and small invertebrates (Davidson 2004, p. 1892; Relyea 2005, p. 1118; Brühl et al. 2013, p. 1). Thus, a potential reduction of prey due to contaminants may have negative impacts at the individual and population level of western pond turtle. Per- and polyfluoroalkyl substances (PFAS) are common contaminants in the environment that bioaccumulate in other turtle species, with negative metabolic impacts for individuals (Beale et al. 2022, entire). The specific impacts from PFAS to western pond turtle populations are not known. Pesticides are of particular concern as their use in California has historically been and continues to be widespread, and they can expand beyond the area to which they are applied via spray drift, sorption, leaching, volatilization, and surface runoff (Majewski and Capel 1995, entire; Tudi et al. 2021, pp. 6–8). Differences in exposure to pesticides depend on the proximity of the population to agricultural pollution. For example, pesticides (semi-volatile organic compounds; SOCs) were detected in the plasma of populations of western pond turtles at higher concentrations in two sites closest to agricultural sources (Meyer et al. 2016, p. 330). Some pesticides, such as organophosphates and carbamates, are known to inhibit cholinesterase enzyme (ChE) in wildlife, thus ChE activity can be used as an indicator of pesticide exposure (Meyer et al. 2013, p. 692). Western pond turtles from areas within the Sierra Nevada had significantly depressed ChE activity by 31 percent compared with other areas farther north in the range (Meyer et al. 2013, pp. 695–696). Despite direct evidence of the presence of ChE depression occurring in the northwestern pond turtle, the effects of it are still unknown in the species. However, it could impact neurotransmission and neuromuscular function (Meyer et al. 2013, p. 696). In addition to pesticide exposure in agricultural areas, additional noteworthy sources of contaminants are old mines and diesel spills. Mercury has been found in western pond turtles and is still found in ecosystems surrounding historic gold mining sites throughout California (Meyer et al. 2014, p. 2994) and historic mercury sulfide (cinnabar) mining sites in Santa Clara County in California (Service 2013, pp. 43–44; AECOM 2021, p. 1). Elevated concentrations of mercury, lead, and arsenic have been found in fish and waterfowl species in the Carson River area in Nevada, but western pond turtles in this area have not been tested (NDOW 2022, in litteris). In several populations of western pond turtles, blood plasma analyses revealed consistent relationships between mercury concentrations in red blood cells and evidence of disruption of thyroid hormones, which are known to be critical to growth, development, and reproduction (Meyer et al. 2014, p. 2994). It is unknown at what level of exposure to mercury and/or pesticides would have biologically detrimental effects at the individual level or population level in western pond turtles. Also, even when contaminants occur in blood at concentrations below many diagnostic thresholds, it is possible that multiple contaminants at low concentrations could interact synergistically (Meyer et al. 2016, p. 333). In a study documenting a variety of contaminants (organochlorines, PCBs, and metals) in Eugene, Oregon, no relationship was found between egg hatchability and contaminant levels. However, these contaminants are known to disrupt proper sexual development, immune function, or survival of hatchings. Although diesel spills in freshwater are uncommon, there is evidence that when they do occur they can result in mortality. In California, a diesel spill from a truck into freshwater resulted in mortality of at least one small individual western pond turtle, and negatively impacted the health and behavior of other individuals that were observed (Bury 1972, p. 294). In Oregon, at Yonkalla Creek, in January of 1993, a diesel spill resulted in the death of least 50 (and probably in excess of 100) northwestern pond turtles (Holland 1994, p. 2-13). Of an additional 30 animals collected, 3 died due to delayed reactions and complications (USFWS, 2023).

Stressor: Climate Change (USFWS, 2023).
Exposure:
Response:
Consequence:
Narrative: Climate change is defined by the Intergovernmental Panel on Climate Change (IPCC) as the change in the mean or variability of one or more measures of climate that persist for an extended period, whether the change is due to natural variability or human activity (IPCC 2015, p. 120). Overall trends in climate across the range of the western pond turtle include increasing temperatures, greater proportion of precipitation falling as rain instead of snow, earlier snowmelt, and increased frequency and severity of extreme events such as droughts, heat waves, wildfires, and floods (Bedsworth et al. 2018, pp. 19–33; Oregon Climate Change Research Institute 2019, pp. 5–7). The increased frequency and severity of extreme events increases extirpation risk of western pond turtles from catastrophic events. Impacts in climate trends and change are expected to vary throughout the range of the species (USFWS, 2023).

Recovery

Conservation Measures and Best Management Practices:

-

Additional Threshold Information:

-
-

References

USFWS. 2023. Species Status Assessment Report for the Northwestern Pond Turtle (Actinemys marmorata) and Southwestern Pond Turtle (Actinemys pallida), Version 1.1. Species Status Assessment Reports. Ventura, California.

88 FR. No. 190. Pages 68370-68399. Endangered and Threatened Wildlife and Plants

Threatened Species Status With Section 4(d) Rule for the Northwestern Pond Turtle and Southwestern Pond Turtle. Proposed Rule.

SPECIES ACCOUNT: *Actinemys marmorata pallida* (Southwestern pond turtle)

Species Taxonomic and Listing Information

Listing Status: Proposed Threatened

Physical Description

The western pond turtle is a medium-sized turtle (Figure 1). Size varies geographically, with the largest animals occurring in the northern part of the range (Holland 1994, pp. 2-3). The maximum carapace (shell) length (CL) of northwestern pond turtles is 241 millimeters (mm) (Lubcke and Wilson 2007, p. 110), and maximum CL of southwestern pond turtles in 179 mm (Germano and Riedle 2015, p. 104). Northwestern pond turtle adults typically range in size between 160 to 180 mm long and weigh between 500 to 700 grams (Bury et al. 2012, p. 4), while southwestern pond turtles range from 110 to 179 mm long and weigh between 194 to 828 grams (USFWS, 2023).

Taxonomy

Western pond turtles are currently identified as being in the family Emydidae; Class: Reptilia, Order: Testudines, Suborder: Cryptodira, and Superfamily: Testudinoidea. The species was first identified in 1852 as Emys marmorata from specimens collected from Puget Sound, Washington (Baird and Girard 1852, pp. 174–177). Past taxonomy for the western pond turtle is further detailed in Bury et al. (2012, pp. 1–3), including designation as species or subspecies; and classification in the genera Emys, Actinemys, or Clemmys. There has also been suggestion of three morphologically distinct groups (Holland 1994, p. 2-3) or four distinct clades based on genetic variation, with three occurring south of San Luis Obispo (Spinks and Shaffer 2005, entire). In recent publications, the genus name is interchanged between Emys and Actinemys with several authorities placing the two species in the more inclusive Emys or the more narrowly defined Actinemys (Stephens and Wiens 2003, p. 596; Fritz et al. 2011, entire; Spinks et al. 2016, entire; Turtle Taxonomy Working Group et al. 2017, pp. 75–76). Because the genus name is interchanged between Emys and Actinemys, the species names may be seen in both forms as well. Spinks et al. (2014, entire) recommended splitting the western pond turtle into two separate species, and this split was recognized in taxonomic lists in 2017 (Crother 2017, p. 82; Turtle Taxonomy Working Group et al. 2017, p. 76). The current authoritative list of the subject, the Turtle Taxonomy Working Group checklist, refers to the two species as northwestern pond turtle (Actinemys marmorata) and southwestern pond turtle (Actinemys pallida) (Turtle Taxonomy Working Group et al. 2021, pp. 171–172). Based on the recognition by the scientific community, and in following with the Society for the Study of Amphibians and Reptiles and the Turtle Taxonomy Working Group, the Service recognizes northwestern pond turtle and southwestern pond turtle as separate species. Some common names that are associated with western pond turtles are: Pacific pond turtle, Pacific mud turtle, Pacific terrapin, and western mud turtle (USFWS, 2023).

Historical Range

The historical range of western pond turtles extends along the Pacific coast from British Columbia, Canada to the northern part of Baja California, Mexico, primarily west of the Sierra Nevada and Cascade ranges (Ernst and Lovich 2009, p. 173; Stebbins and McGinnis 2018, p.

205). Western pond turtles have been found at sites from brackish estuarine waters at sea level up to 2,048 meters (m) (6,719 feet (ft) (Ernst and Lovich 2009, p. 176) but mostly occur below 1,371 m (4,980 ft.) (Stebbins and McGinnis 2018, p. 205). Several isolated populations occur, including but not limited to those in the vicinity of Puget Sound, Columbia Gorge, the Mojave River in California, and the Carson and Truckee Rivers in Nevada (Holland 1994, p. 2-4). . Historical accounts from Vancouver Island and mainland British Columbia, Canada in the lower Fraser River watershed may represent transplanted individuals; no reports of the species are known from either region since 1966 (Gregory and Cambell 1984 in Ernst and Lovich 2009, p. 173), and western pond turtles are considered extirpated from British Columbia, Canada (Ministry of Environment 2012, p. iv). Single records from southwestern Idaho and Grant County, Oregon (Nussbaum et al. 1983 in Ernst and Lovich 2009, p. 173) are likely introduced (Ernst and Lovich 2009, p. 173), and other isolated populations within the species' native range may also represent introductions (USFWS, 2023).

Current Range

The current range of the southwestern pond turtle is restricted to those populations inhabiting the central Coast Range south from the middle of Monterey Bay to the species' southern range boundary in Baja California (USFWS, 2023).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Food Source

<u>Adult:</u> fish, tadpoles, and frogs. dragonfly larvae, mayflies, stoneflies, caddisflies, midges, beetles, and other insects, including terrestrial prey items (e.g., grasshoppers) (USFWS, 2023).

Food/Nutrient Narrative

<u>Adult:</u> The western pond turtle is omnivorous and considered a dietary generalist (Holland 1994, p. 2- 5), consuming a wide variety of food items. Prey resources are primarily found within water but can be captured or scavenged on land. Food captured or scavenged on land must be brought back to water for consumption, as they appear to be unable to swallow in the air (Holland 1994, p. 2- 6). Animal matter appears to constitute a larger portion of the diet than plant material (Bury 1986, pp. 518–520; Holland 1994, pp. 2-5–2-6). Stomach contents reveal the diet consists of small aquatic invertebrates, with small vertebrates (fish, tadpoles, and frogs), carrion, and plant material (Bury 1986, p. 516; Holland 1994, pp. 2-5–2-6). In northern California, contents of 77 stomachs included aquatic insects such as dragonfly larvae, mayflies, stoneflies, caddisflies, midges, beetles, and other insects, including terrestrial prey items (e.g., grasshoppers) (Bury 1986, p. 516). Bury (1986, p. 517) found that 44 percent of the females consumed plant material compared to 10 percent of the males. Juveniles consumed mostly invertebrates (Bury 1986, p. 517), and hatchlings primarily feed on nekton and larvae of small aquatic insects (USFWS, 2023).

Reproductive Strategy

<u>Adult:</u> Oviparity (USFWS, 2023)

Lifespan

Adult: The maximum lifespan of western pond turtles is unknown. However, they are long-lived species after reaching adulthood, with some living to at least 55 years of age (Bury et al. 2012, p. 17). These old individuals are rare in natural populations, but they appear to reproduce throughout their life span based on a radiograph of a 55 year old female with eggs (USFWS, 2023).

Breeding Season

Adult: Oviposition usually occurs from May through July, with northern populations depositing eggs later in the season than those in the south (USFWS, 2023)

Reproduction Narrative

Adult: The time from ovulation of eggs to oviposition in the nest is unknown. Oviposition usually occurs from May through July, with northern populations depositing eggs later in the season than those in the south (Bury et al. 2012, p. 15). Gravid female turtles generally leave the water in the late afternoon or early evening and move into upland habitats to excavate a nest (Holland 1994, p. 2-10). Females may be out of the water for a few hours to several days with nest completion taking anywhere from 2 to more than 10 hours. Females may make several forays into the upland prior to actual oviposition, and sometimes make false scrapes where they abandon the nest prior to laying eggs, potentially as a result of hitting rocks or roots or because of disturbance, which western pond turtles are extremely sensitive to (Holland 1994, p. 2-10; Bury and Germano 2008, p. 001.5). Females will moisten the soil around the nest by urinating prior to digging the nest chamber (Holland 1994, p. 2-10; Hays et al. 1999, p. 12). Females excavate nests 3 m to 500 m from water in compact, dry soils (Storer 1930, p. 434; Holland 1994, p. 2-10; Holte 1998, p. 54), with an average linear distance from water of 51 m (Davidson and Alvarez 2020, p. 44). Localized soil conditions, as well as the frequency and degree of disturbance in the upland habitat, probably limit nest distribution (Thomson et al. 2016, p. 300). Soils need to be loose enough to allow nest excavation, and typically have a high clay or silt component. Disturbance needs to be infrequent enough or of sufficiently low intensity that nesting females are not disturbed (Ernst and Lovich 2009, p. 178). Nests are shallow and generally occur between 9 to 12 cm below the surface (Holland 1994, p. 2-10). After the nest is excavated and eggs deposited, females pack the chamber using surrounding material such as mud, dry soil, and vegetation to form a plug that closes off the neck of the nest chambe Western pond turtles exhibit temperature-dependent sex determination (TSD) during incubation (Ewert et al. 1994, p. 7). In California, female hatchlings were more likely when 30 percent of the sex-determining period occurred above 29° Celsius (C) (84° Fahrenheit (F)) (Christie and Geist 2017, p. 49). In addition, lower fluctuations in temperature resulted in development of males, whereas females developed in nests with high and low temperature fluctuations. Temperatures within nests were found to fluctuate daily, varying by more than 20°C (36°F) on a daily basis (Geist et al. 2015, p. 498; Christie and Geist 2017, p. 50). Higher maximum temperatures reduce overall egg viability. (USFWS, 2023)

Habitat Type

Adult: Semi-aquatic (USFWS, 2023)

Habitat Vegetation or Surface Water Classification

Adult: Streams/ponds/reservoirs/marshes/estuaries (USFWS, 2023)

Environmental Specificity

Adult: High

Site Fidelity

Adult: Moderate

Habitat Narrative

Juvenile: Hatchlings While few studies have tracked hatchlings leaving the nest, available studies show variation in timing of emergence and behavior post-emergence. In southern and central California, some hatchlings may emerge from the nest chamber in late-summer to early-fall, whereas others overwinter in the nest chamber and emerge in spring (Holland 1994, p. 2-10). In the northern parts of the range, hatchlings overwinter in the nest (Holland 1994, p. 2-10; Reese and Welsh Jr 1997, p. 354). In western Oregon, hatchlings delayed emergence until spring, and typically remained within 2 m of nests for as long as 59 days after initial emergence (Rosenberg and Swift 2013, entire). During migration from their nests to aquatic habitat, hatchlings embedded themselves in soil for up to 22 days at stop-over sites. Hatchlings entered aquatic habitat on average 49 days after initial emergence and traveled an average of 89 m from their nest site. Hatchlings detected in water were always within 1 m of shore and in areas with dense submerged vegetation and woody debris (Rosenberg and Swift 2013, entire). Growth Hatchlings can nearly double in size by the end of the first year (Germano and Rathbun 2008, p. 189; Germano 2010, p. 95; Bury et al. 2012, p. 17). Growth rates vary based on factors including developmental conditions, environmental conditions, geography, and individual variation (Bury et al. 2012, p. 16). For example, Holland (1994, p. 2-11) notes that turtles between 100 to 110 mm are generally 4 to 5 years old, but may be as young as 3 or as old as 12. Northwestern pond turtles in Oregon were slightly larger than the same species in California, although the growth rate to achieve these sizes was slower, possibly because of cooler temperatures. Age and size reached at sexual maturity is poorly understood and varies between sites and geography (Holland 1994, pp. 2-9, 5-2; Rosenberg et al. 2009, p. 22; Bury et al. 2012, p. 15). In general, males tend to exhibit external signs of sexual dimorphism around 110 to 120 mm CL (Bury et al. 2012, p. 15). In coastal central California, the average male reached 120 mm CL in 3.6 years compared to 4.1 years for females, and reached 150 mm CL in 8.3 years for males versus 11.1 years for females (Germano and Rathbun 2008, pp. 190–191). In Washington, males are thought to achieve sexual maturity when they are at least 10 to 12 years old (USFWS, 2023).

Adult: Western pond turtles are semi-aquatic, requiring both aquatic and terrestrial habitats that are within close proximity and connected to one another (Figure 7). As habitat generalists, western pond turtles occur in a broad range of permanent and ephemeral aquatic water bodies from remote to urban landscapes, including flowing rivers and streams, lakes, ponds, reservoirs, settling ponds, marshes, vernal pools irrigation ditches, and other wetlands, including some with estuaries with tidal influence (Spinks et al. 2003, entire; Bury and Germano 2008, p. 001.3; Ernst and Lovich 2009, p. 175; Bury et al. 2012, p. 12; Stebbins and McGinnis 2018, p. 205). Despite their ability to use a wide range of aquatic features, suitable aquatic habitats are relatively rare across much of the range, exacerbated by land use changes (e.g., urbanization and agriculture) after European settlement (discussed more in Chapter 8.1: Habitat Loss and Fragmentation). Consequently, the species' distribution may be disjunct across the landscape, following the arrangement of ponds or streams, especially in areas with extensive open, dry terrain between waterways (Bury et al. 2012, p. 12). The back-and-forth movements between aquatic and terrestrial habitats (i.e., migration) are typically less than 500 m (Reese and Welsh Jr 1997, p. 357), thus the two habitat types must be adjacent. In a study in northern California, radio-tagged males used terrestrial habitat in at least ten months of the year, emphasizing the importance of upland habitat in addition to aquatic habitat (USFWS, 2023).

Dispersal/Migration

Motility/Mobility

Adult: High

Dispersal

Adult: Moderate. Genetic analyses suggest that most movements occur within drainages (Spinks and Shaffer 2005, p. 2057), but few accounts of adult and juvenile dispersal exist. Within aquatic habitat, a dispersal distance of 7 km upstream was observed (5 km overland distance) (Holland 1994, p. 7-28). Dispersal may also occur via aquatic habitats during flood events (USFWS, 2023).

Dispersal/Migration Narrative

Adult: Migration: We define migration for the western pond turtle to be intra-population (within local populations) movements occurring between aquatic and upland environments. Migrations are often roundtrip and reoccurring (often seasonally, but not always annually), such as when individuals are moving from aquatic to upland environment (and back) for the purpose of nesting, overwintering, and aestivation. Males generally move farther than females or juveniles (Bury 1972a, pp. 65–66). Measured home ranges of western pond turtles average 1 hectare (2.5 acres) for males, 0.3 hectare (0.7 acre) for females, and 0.4 hectare (1 acre) for juveniles (Bury 1972a). Overwintering behavior is variable, and likely more common in seasonally inundated ponds than permanent water (Pilliod et al. 2013, p. 216). Using radio-telemetry, Holland (1994, pp. 6-12–6- 13) found overwintering sites at two streams/rivers that ranged from 15 to 260 m away from the aquatic environment. In northern California along the Trinity River, some turtles sought upland refuge to either overwinter or aestivate while others moved to lentic bodies of water (standing bodies of water) as far as 500 m from the river (Reese and Welsh Jr 1997, p. 356). The pattern and frequency of these migrations vary with habitat, size of the aquatic system, suitability of upland habitat, season, climate, environmental stress (e.g., drought, high stream flow), sex, and life stage (Hallock et al. 2017, p. 4). In central California, radio-tagged turtles spent over half of the year in terrestrial habitat, moving from 255 to 1,096 m over the study period but never moving farther than 343 m from seasonal ponds. Western pond turtles moved in different directions, used different microhabitats, and left ponds at different times. Dispersal: Dispersal of western pond turtles between populations/watersheds is generally not well understood. Genetic analyses suggest that most movements occur within drainages (Spinks and Shaffer 2005, p. 2057), but few accounts of adult and juvenile dispersal exist. Within aquatic habitat, a dispersal distance of 7 km upstream was observed (5 km overland distance) (Holland 1994, p. 7-28). Dispersal may also occur via aquatic habitats during flood events (Rosenberg et al. 2009, p. 21). Along the central California coast, Holland (1994, p. 2-9) recorded less than 10 dispersal events between drainages during a 10-year study with over 2,100 captures and recaptures across 21 drainages, suggesting that overland movements are uncommon. In that study, the longest overland distance recorded in an area considered to be under the best circumstances (mild climate and short distances between water features), was a single individual travelling 5 km. Holland (1994, p. 2-9), also states that no movements between drainages were detected from three other sites with over 1,100 hundred captures and recaptures over a 7-year period. During an extreme drought, Purcell et al. (2017, pp. 21, 24) documented a 2.6 km straight-line distance movement overland in a radio-tagged turtle, with a minimum total distance of 3.3 km moved before the individual found water (USFWS, 2023).

Population Information and Trends

Population Trends:

Declining. The impact of these threats has caused the distribution and abundance of the southwestern pond turtle to decline, especially in the southern parts of California that are associated with the developed and highly urbanized areas of southern Los Angeles, Orange, and San Diego Counties (AU–5), although some stable populations with relatively high abundance and evidence of reproduction do still occur in these areas, especially in areas further north along the California Coast Range outside urbanized areas (Jennings and Hayes 1994, pp. 99, 101; Thomson et al. 2016, p. 301). Status trends and abundance for areas in Baja California are not available, but information suggests that similar conditions exist for the species in Mexico, based on recent occupancy and distribution of populations of the species. Despite populations of the species being impacted by the existing threats, the species currently continues to maintain populations (88 FR 68392).

Resiliency:

Across all southwestern pond turtle analysis units in California, populations declined for the duration of the model simulation, with the probability of extirpation rising over time. Model results were most sensitive to increases in drought, especially in the Ventura/ Santa Barbara (AU–2), LA (AU–4), and Orange County/San Diego (AU–5) analysis units. The probability of extirpation for all the analysis units in 2075 was above 50 percent and ranged from 54 percent (AU–1) to 57 percent (AU–3) under scenario 1 (RCP 8.5 (SSP 5)) and 51 percent (AU–5) to 55 percent (AU–3) under scenario 2 (RCP 4.5 (SSP 2)). These results suggest that the populations in some of the analysis units are likely to become extirpated and that all populations across the species' range in California would be less able to withstand stochastic events within the next 50 years. The probability of extirpation of all the analysis units in 2100 increases substantially to over 70 percent, ranging from 73 percent (AU–1) to 78 percent (AU–2) under scenario 1 and 70 percent (AU–5) to 73 percent (AU–2) under scenario 2 (Service 2023, pp. 107, 108 (figures 32 and 33)). This indicates a 70 to 78 percent likelihood of extirpation of the populations for each analysis unit in the next 75 years under either plausible future scenario. Under both scenarios, multiple analysis units are projected to be at risk of extirpation and resiliency would be reduced such that the species is less able to withstand environmental stochasticity. Table 3 below, identifies the range of the probability of extirpation (highest and lowest percentage) of analysis units for the southwestern pond turtle in 2050, 2075, and 2100. (88 FR 68386).

Representation:

Representation of southwestern pond turtles would be reduced with extirpation of any analysis units. As stated above, based on probability of extirpation, all analysis units in the U.S. portion of the range have greater than a 50 percent probability of extirpation or are more likely than not to become functionally extinct by 2075 and have over a 70 percent probability of becoming functionally extinct by 2100. With projected losses in both future scenarios, the species may lose occupancy throughout most of its current distribution. Inbreeding depression and loss of genetic diversity would be exacerbated as abundance declines across analysis units with increasing probability of populationlevel extirpations. Even without the overall extirpation of analysis units, additive loss of individuals over time leads to an overall decline in species genetic diversity due to increased probability of inbreeding, genetic drift, and increasing the potential for incorporating detrimental genetic traits into a population, which decreases adaptive potential (Palstra and Ruzzante 2008, entire). Therefore, under both future scenarios, representation in southwestern pond turtles is likely to be severely reduced in the next approximately 50 to 75 years, such that the species will be less able to adapt to changing conditions (88 FR 68386-68387).

Redundancy:

Based on projections of probability of extirpation, loss of all 5 analysis units in the U.S. is greater than 50 percent under both scenarios by 2075. Therefore, all U.S. analysis units are more likely than not to become functionally extinct in approximately 50 years. There is a possibility that the species could maintain some of its current distribution in those waterbodies most resistant to anthropogenic impacts, bullfrog predation, and drought, which would continue to offer some low level of redundancy for the species. However, increasing probability of extirpation across analysis units and contraction of the range mean that the species would be less likely to withstand catastrophic events under either future scenario in approximately 50 years. By 2100, all California analysis units are substantially likely (greater than 70 percent) to be functionally extinct under both scenarios. Given the increasing probability of extirpation predicted across analysis units and contraction of the range, the species would be much less likely to withstand catastrophic events under either future scenario in approximately 75 years. (88 FR 68386).

Threats and Stressors

Stressor: Altered Hydrology (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Aquatic resources used by the western pond turtle have experienced high levels of loss, alteration, and degradation throughout the range of the two species (Reese and Welsh Jr. 1998b, p. 505; Germano 2010, p. 89). A substantial portion of the losses of aquatic habitat are due to anthropogenic water use (e.g., dams and diversions for the purposes of providing water for human use). Moreover, within the historical range of the western pond turtle, an extensive system of hydrologic infrastructure, including dams, reservoirs, diversions, and aqueducts, supports extensive agricultural and municipal water uses, and provides domestic water to many densely populated areas (Lund et al. 2007, p. 43; Hanak et al. 2011, pp. 19–69). These alterations include stream channelization, altered flow regimes, groundwater pumping, water diversions, damming, and water regulation for flood risk management (flood control), which affect hydrology, thermal conditions, and structure of western pond turtle aquatic and upland habitat. More recently, rapid expansion of marijuana agriculture in the western United States is associated with extensive water use. Marijuana farms are slightly closer to streams and rivers than available private parcels (Parker-Shames et al. 2022, pp. 9–11), which has potential implications to freshwater species such as the western pond turtle. Water diversions for marijuana cultivation have decreased stream flow in some areas in Northern California with negative impacts to sensitive fish and amphibians species (Bauer et al. 2015, entire), although we are not aware of specific studies on impacts to western pond turtles. Altogether, hydrologic alterations have contributed to loss of habitat for the species, which is incorporated in the above section, and can have long-lasting impacts in areas where habitat does remain (USFWS, 2023).

Stressor: Recreation (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Recreational activities such as hiking, biking, fishing, boating, and off-highway vehicles, and the associated disturbance within or adjacent to aquatic and nest habitats, can affect western pond turtles in a variety of ways, depending on the region and type of recreation. Some forms of recreation may cause mortality of individuals through trampling, while others degrade habitat, disturb pond turtle behavior, and/or contribute to other threats. For example, recreational activities may interact with the threat of collection because humans may encounter the species while engaging in other activities. Western pond turtles are extremely wary and will rapidly flee from basking sites into the water when disturbed by the sight or sound of people at distances of greater than 100 m (328 ft) (Bury and Germano 2008, p. 001.5). Western pond turtles at the University of California, Davis, Arboretum were more abundant in basking sites that were farther from human paths, presumably to avoid human disturbance (Lambert et al. 2013, p. 196). In another example, human activity associated with trail use and an adjacent levee road near Moffett Federal Airfield in the San Francisco Bay Area decreased emergent basking by western pond turtles, although in this case there was a higher rate of disturbance associated with vehicular use on the adjacent levee than for trail use by runners, walkers, and bicyclists (Nyhof and Trulio 2015, p. 183). Whether the disturbance is by vehicles or humans, reducing the amount of time performing this behavior has potential effects on metabolism, proper digestion, feeding, reproduction, growth, and predator avoidance (USFWS, 2023).

Stressor: Predation (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Western pond turtles are impacted by both nonnative and native predators. Nonnative predators include American bullfrogs (Lithobates catesbeianus; hereafter bullfrogs) and invasive fish, such as large and smallmouth bass (Micropterus sp.; hereafter bass). Native predators of western pond turtles include raccoons, skunks, foxes, coyotes. mink, herons, river otters, burrowing small mammals, and giant water bugs (USFWS, 2023).

Stressor: Nonnative Species Competition (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Competition with nonnative species may be a threat to the western pond turtle, particularly when resources are otherwise limited, such as basking sites and/or prey items. The red-eared slider has been identified as the main potential competitor for western pond turtles, but direct evidence of competition is limited. Red-eared sliders are listed as one of the “world’s worst invasive species” by the International Union for Conservation of Nature (IUCN) (Lowe et al. 2000, p. 6). They are common in areas near dense human populations, with red-eared slider numbers likely reinforced by releases or escapes of pets (Thomson et al. 2010, p. 300; Lambert et al. 2013, p. 196). Because red-eared sliders are often found in habitat heavily degraded by human activities, identifying the negative impacts from red-eared sliders versus effects from other coexisting threats can be difficult, especially in complex environments (Dupuis-Desormeaux et al.

2022, pp. 2–3). However, redeared sliders have been tied to declines in Sonora mud turtles (Kinosternon sonoriense) because of interference for basking sites in a before-after study in an undisturbed natural environment (Drost et al. 2021, entire). Under experimental conditions, red-eared sliders negatively impacted weight and survival of European pond turtles (Emys orbicularis) (Cadi and Joly 2004, pp. 2514– 2515) and negatively impacted basking activity for Spanish terrapins (Mauremys leprosa) (USFWS, 2023).

Stressor: Disease (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Disease has been and is an emerging concern for western pond turtle populations. Documented diseases in western pond turtles include respiratory disease and shell disease. In 1990, an unidentified pathogen causing an upper respiratory disease killed more than a third (at least 36 individuals) of the extant western pond turtles in Washington at that time (Hays et al. 1999, p. 14; Hallock et al. 2017, p. 9). Additional cases of respiratory disease have not been detected in Washington, but two cases were documented in Oregon (B. Bury, pers. comm. in Hallock et al. 2017, p. 9). Pathogen sampling in western pond turtles in California detected Mycoplasma species (a type of bacteria) in northern, central, and southern California turtles, with infected turtles having lower body weights. They did not find evidence that sympatry with nonnative redeared sliders correlated with pathogen occurrence (Silbernagel et al. 2013, pp. 41–43). We are also aware of leeches, including in the genus Hellodelba and the introduced Placobdella parasitica, that have been reported on western pond turtles (S. Barnes 2023, in litteris; D. Ashton 2023, in litteris), but the ecology between these leeches and western pond turtles is poorly understood and is not discussed further in this report. For the remainder of this section, we focus on shell disease (USFWS, 2023).

Stressor: Road Impacts (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Although roads are tightly linked to urbanization and development, roadways also exist as a standalone threat since their presence is not always associated with urban or developed areas. Thus, we address roadways independently but also consider that the effects are synergistic with urbanization. Roads can affect western pond turtle viability because of vehicles killing or injuring individuals or disturbing basking behavior, and by reducing connectivity between populations, which reduces migration between upland and aquatic habitat (Rosenberg et al. 2009, p. 41; Nyhof 2013, p. 43; Thomson et al. 2016, p. 301; Nicholson et al. 2020, entire; Manzo et al. 2021, p. 494, S1 text supplement). Railroad tracks can also serve as barriers to migration, as is observed in other turtle/tortoise species (Rautsaw et al. 2018, pp. 138–139). There have been no documented western pond turtle population extirpations attributed directly to roadways. Additional threats that have associated affects with roads include: increased fragmentation (roads further break up the landscape), recreation (roads increase access to habitat), collection (roads increase access for humans), contamination (runoff of contaminants), and predation (roads increase access for predators), and an interaction with drought (drought causes turtles to spend more time in upland habitat, increasing potential to interact with roads). Despite the high likelihood that these threats have compounding impacts, there is limited direct evidence in the literature about their combined effects on western pond turtle. Many direct

mortality events have been documented on roads, but these effects have mostly been documented at the individual rather than the population level. Although roads are known to create dispersal barriers, there are no formal assessments of the impact of roads on connectivity of western pond turtles at the population level. Thus, it is difficult to assess the impact of roads on population-level parameters. However, in a road risk assessment ranking susceptibility of California herpetofauna to road mortality and habitat fragmentation, Brehme et al. (2018, p. 921) classified northwestern pond turtles and southwestern pond turtles as very high risk (both in the top 10 out of 160 species evaluated) (USFWS, 2023).

Stressor: Collection (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Collection of western pond turtles directly removes individuals from a population and can lead to reduced reproduction and recruitment. This is especially the case in populations that are fragmented or where numbers of individuals are already low. Extensive collection is widely reported along with habitat alteration and habitat loss (discussed above) as primary factors initially responsible for declines of both species (Holland 1994, p. 2-13; Hays et al. 1999, p. 16; Bettelheim 2005, entire; Rosenberg et al. 2009, p. 42; Thomson et al. 2016, p. 301). The true extent of these declines associated with collection remains largely unknown. However, Bettelheim (2005, entire) and Bettelheim and Wong (2022, entire) provide a thorough review of collection for commercial harvest occurring between the mid to late 1800s and early 1900s. At the height of collection in 1895, approximately 63,000 individuals from the San Francisco Bay area and Central Valley of California were marketed (Bettelheim and Wong 2022, p. 9). This was followed by approximately 53,935 individuals marketed for several years until the turn of the century from San Joaquin, Solano, Sonoma, Stanislaus, and Contra Costa Counties for the commercial terrapin fishery in California (Bettelheim 2005, p. 32; Bettelheim and Wong 2022, p. 9). Numbers in the thousands from several counties throughout California accounted for turtles collected for the San Francisco market with large numbers coming from the Sacramento and San Joaquin regions (Bettelheim 2005, pp. 32–33). In 1883, one trapper on Tulare Lake collected a minimum of 3,600 individuals. In 1904, not accounting for other collections during that time, an estimated 12,740 individuals were collected from San Joaquin and Sacramento Counties (Bettelheim 2005, pp. 32–33). Bettelheim and Wong (2022, p. 10) suggest that historic collection between 1863 and 1931 resulted in the collection of approximately 524,100 individuals and could be over a million individuals (Bettelheim and Wong 2022, p. 10) collected for the San Francisco market, and likely other markets in California, Oregon, and Washington (Holland 1991, p. 44). Collecting for commercial harvest likely had an impact on turtle populations by removing a greater number of reproductively viable adults and, consequently, acted as an intense population suppressant (USFWS, 2023).

Stressor: Toxins (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Although western pond turtles are exposed to a variety of toxins throughout their range, sensitivity of individuals to pesticides, heavy metals, pollutants, and other contaminants is largely unknown. However, contaminants in general have been identified as a significant threat in freshwater ecosystems both through indirect or through direct toxicity to organisms (Reid et

al. 2019, p. 9). Potential affects to long-lived species such as the western pond turtle are discussed in Rowe (2008, entire). For example, because western pond turtles take multiple years to reach reproductive maturity (see Chapter 5.0 Life History), potential effects from contaminants include mortality before reproduction, or chronic accumulation of contaminants that could be transferred to offspring (Rowe 2008, p. 626). Sources of contaminants affecting western pond turtles include run-off or drift from agricultural activities, run-off from mining sites, diesel spills, run-off from urbanized areas, and roadways. Pesticides and mercury are the most studied contaminants, but little to nothing is known about the biological implications. For example, variable amounts of organochlorine pesticides, polychlorinated biphenyls (PCBs), and mercury were detected in western pond turtle eggs at a site in Oregon, but differences in concentrations of these contaminants were not related to egg hatchability in the study (Henny et al. 2003, pp. 49–51). Contaminants can be toxic to aquatic prey items of western pond turtle such as amphibians and small invertebrates (Davidson 2004, p. 1892; Relyea 2005, p. 1118; Brühl et al. 2013, p. 1). Thus, a potential reduction of prey due to contaminants may have negative impacts at the individual and population level of western pond turtle. Per- and polyfluoroalkyl substances (PFAS) are common contaminants in the environment that bioaccumulate in other turtle species, with negative metabolic impacts for individuals (Beale et al. 2022, entire). The specific impacts from PFAS to western pond turtle populations are not known. Pesticides are of particular concern as their use in California has historically been and continues to be widespread, and they can expand beyond the area to which they are applied via spray drift, sorption, leaching, volatilization, and surface runoff (Majewski and Capel 1995, entire; Tudi et al. 2021, pp. 6–8). Differences in exposure to pesticides depend on the proximity of the population to agricultural pollution. For example, pesticides (semi-volatile organic compounds; SOCs) were detected in the plasma of populations of western pond turtles at higher concentrations in two sites closest to agricultural sources (Meyer et al. 2016, p. 330). Some pesticides, such as organophosphates and carbamates, are known to inhibit cholinesterase enzyme (ChE) in wildlife, thus ChE activity can be used as an indicator of pesticide exposure (Meyer et al. 2013, p. 692). Western pond turtles from areas within the Sierra Nevada had significantly depressed ChE activity by 31 percent compared with other areas farther north in the range (Meyer et al. 2013, pp. 695–696). Despite direct evidence of the presence of ChE depression occurring in the northwestern pond turtle, the effects of it are still unknown in the species. However, it could impact neurotransmission and neuromuscular function (Meyer et al. 2013, p. 696). In addition to pesticide exposure in agricultural areas, additional noteworthy sources of contaminants are old mines and diesel spills. Mercury has been found in western pond turtles and is still found in ecosystems surrounding historic gold mining sites throughout California (Meyer et al. 2014, p. 2994) and historic mercury sulfide (cinnabar) mining sites in Santa Clara County in California (Service 2013, pp. 43–44; AECOM 2021, p. 1). Elevated concentrations of mercury, lead, and arsenic have been found in fish and waterfowl species in the Carson River area in Nevada, but western pond turtles in this area have not been tested (NDOW 2022, in litteris). In several populations of western pond turtles, blood plasma analyses revealed consistent relationships between mercury concentrations in red blood cells and evidence of disruption of thyroid hormones, which are known to be critical to growth, development, and reproduction (Meyer et al. 2014, p. 2994). It is unknown at what level of exposure to mercury and/or pesticides would have biologically detrimental effects at the individual level or population level in western pond turtles. Also, even when contaminants occur in blood at concentrations below many diagnostic thresholds, it is possible that multiple contaminants at low concentrations could interact synergistically (Meyer et al. 2016, p. 333). In a study documenting a variety of contaminants (organochlorines, PCBs, and metals) in Eugene, Oregon, no relationship was found between egg hatchability and contaminant levels. However, these contaminants are known to disrupt proper sexual development, immune function, or survival of hatchings. Although diesel spills in freshwater are uncommon, there is evidence that when they do occur they can result in mortality. In California, a diesel spill from a truck into freshwater resulted in mortality of at least one small individual western pond turtle, and negatively impacted the health and behavior of other individuals that were observed (Bury 1972, p. 294). In Oregon, at Yonkalla Creek, in January of 1993, a diesel spill resulted in the death of least 50 (and probably in excess of 100) northwestern pond turtles (Holland 1994, p. 2-13). Of an additional 30 animals collected, 3 died due to delayed reactions and complications (USFWS, 2023).

Stressor: Climate Change (USFWS, 2023).
Exposure:
Response:
Consequence:
Narrative: Climate change is defined by the Intergovernmental Panel on Climate Change (IPCC) as the change in the mean or variability of one or more measures of climate that persist for an extended period, whether the change is due to natural variability or human activity (IPCC 2015, p. 120). Overall trends in climate across the range of the western pond turtle include increasing temperatures, greater proportion of precipitation falling as rain instead of snow, earlier snowmelt, and increased frequency and severity of extreme events such as droughts, heat waves, wildfires, and floods (Bedsworth et al. 2018, pp. 19–33; Oregon Climate Change Research Institute 2019, pp. 5–7). The increased frequency and severity of extreme events increases extirpation risk of western pond turtles from catastrophic events. Impacts in climate trends and change are expected to vary throughout the range of the species (USFWS, 2023).

Recovery

Conservation Measures and Best Management Practices:

-

Additional Threshold Information:

-
-

References

USFWS. 2023. Species Status Assessment Report for the Northwestern Pond Turtle (Actinemys marmorata) and Southwestern Pond Turtle (Actinemys pallida), Version 1.1. Species Status Assessment Reports. Ventura, California.

88 FR. No. 190. Pages 68370-68399. Endangered and Threatened Wildlife and Plants

Threatened Species Status With Section 4(d) Rule for the Northwestern Pond Turtle and Southwestern Pond Turtle. Proposed Rule.

SPECIES ACCOUNT: *Ameiva polops* (St. Croix ground lizard)

Species Taxonomic and Listing Information

Listing Status: Endangered; July 5, 1977

Physical Description

The St. Croix ground lizard (Ameiva polops) is a small species of Ameiva (snout-vent-length 35-77 mm). According to Dodd (1980), this species has a light brown middorsal stripe, bordered by wide dark brown or black stripes below which are narrow parallel stripes of brown, black and white. Continuing on to the tail are the middorsal stripe, bordering stripes and the narrow white stripes. The tail also has alternating rings of blue and black. The top of the head is uniform brown. Chin, throat, chest, sides of the snout and undersides of the forelegs are deep pinkish-red. The belly is a light gray with lateral bluish markings (USFWS, 1984).

Taxonomy

Taxonomic characteristics which distinguish this species from other Ameiva include: 10 (12) longitudinal rows of ventral scales, 33-39 femoral pores, dorsal caudal scales in oblique rows, enlarged median gular scales, and 2 parallel rows of preanal scales (USFWS, 1984).

Historical Range

The St. Croix ground lizard historic distribution included St. Croix, Green Cay, Protestant Cay, and presumably Buck Island (USFWS 1984). At the time of listing, the species was only known from Protestant Cay and Green Cay NWR. The last report of the species in the main island of St. Croix was in 1968 (USFWS 1984) (USFWS, 2013).

Current Range

The distribution of the species has presently expanded as a result of successful translocation efforts. Currently, the species is known from Protestant Cay, Green Cay National Wildlife Refuge, Ruth Cay and Buck Island Reef NM (Figure 1). Green Cay and Protestant Cay are designated critical habitat for the species (USFWS, 2013).

Distinct Population Segments Defined

No

Critical Habitat Designated

Yes; 9/22/1977.

Legal Description

On September 22, 1977, the Director, U.S. Fish and Wildlife Service issued a rulemaking which determined critical habitat for the St. Croix ground lizard (Ameiva polops) pursuant to Section 7 of the Endangered Species Act Of 1973 (42 FR 47840 - 47845). In accordance with section 7, all Federal agencies will be required to insure that actions authorized, funded, or carried out by them do not adversely affect these Critical Habitats.

Critical Habitat Designation

Critical habitat for the St. Croix ground lizard is designated in the U.S. Virgin Islands.

Protestant Cay, roughly defined by the coordinates 64o42'15''N. and 17o45'7.5''W.

Green Cay, roughly define by the coordinates 67o37'30'' N. and 17o46'15'' W.

Primary Constituent Elements/Physical or Biological Features

Not available

Special Management Considerations or Protections

Not available

Life History

Feeding Narrative

Adult: Ameiva polops was noted by Wiley (in prep.) to actively prowl, root and dig for prey. In 1936, Beatty (Grant, 1937) dissected a number of Ameiva and found them to have eaten the amphipods which were abundant along the beach. Philibosian and Ruibal (1971) reported that the hermit crab (Coenobita clypeatus) was a prey item for the animals introduces to Buck Island. Wiley (in prep.) observed that the smaller ground lizards foraging among the tidal wrack took grammarian amphipods flushed form the seagrass, that small white moths were taken from under the forest litter, and that A. polops was frequently observed foraging out of site under the litter or in shallow holes dug by the lizard (USFWS, 1984).

Reproduction Narrative

Adult: No information found

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1984)

Site Fidelity

Adult: High (inferred from USFWS, 1984)

Habitat Narrative

Adult: The St. Croix ground lizard is currently utilizing coastal dry forest vegetation on four offshore islands of St. Croix, USVI (U.S. Virgin Islands). Green Cay NWR is a 5.17 ha (ca. 14.1 acres) islet located in Chenay Bay about 150 m offshore the northeastern coast of St. Croix (McNair and Lombard 2004). McNair and Lombard (2004) provide general descriptions of the habitat of the St. Croix ground lizard in the three most obvious topographical and vegetative features on Green Cay (North, South, and Beach). The north area is comprised primarily of a shrub-grassland association; the south area is primarily open and closed dry and mesic forest with some shrubgrassland association; and the beach area (southern tip, and some margins of the east, west and north coast) has some trees like buttonwood (Conocarpus erectus), manchineel (Hippomane mancinella), sea grape (Coccoloba uvifera) and sea side maho (Thespesia populnea). Lizards were more abundant in forested areas in the southern half of the cay, but scarcer than expected on beaches, especially treeless areas. This is consistent with what Wiley (1984) and Meier et al. (1993) found. Wiley (1984) notes that the most important habitat components selected by the lizard were, suitable substrate for burrowing, presence of leaf or tidal litter, and areas which offered both canopied and exposed sections for thermoregulation. Meier et al. (1993) states tree density is the habitat factor most closely-related to distribution of the St. Croix ground lizard, being observed more frequently where trees were present (USFWS, 2013). Low tolerance range and high site fidelity are based on the species specific habitat needs and low number of populations.

Dispersal/Migration

Motility/Mobility

Adult: High (inferred from USFWS, 1984)

Migratory vs Non-migratory vs Seasonal Movements

Adult: Non-migratory (USFWS, 1984)

Dispersal

Adult: Low (USFWS, 2013)

Immigration/Emigration

Adult: No (USFWS, 2013)

Dispersal/Migration Narrative

Adult: High mobility is inferred based on species taxonomy. Species is non-migratory and has low dispersal and does not immigrate/emigrate because it is limited to relatively small islands (USFWS, 2013).

Population Information and Trends

Population Trends:

Decreasing (USFWS, 2013)

Number of Populations:

Four (USFWS, 2013)

Population Size:

600 to 2,000 total population estimate (USFWS, 2013)

Population Narrative:

USFWS (2013) notes that all but one population appears to be declining. In addition, this document notes that there are 4 known populations totaling an estimated 600 to 2,000 individuals.Low resiliency, redundancy and representation are inferred based on low population numbers and restricted habitat as well as low number of individuals. Currently, the SCGL is considered to have an overall stable population trend, with Buck Island as the best representation of a self-sustaining population. This population is currently estimated at over 1,000 individuals and is predicted to continue dispersing further and possibly reaching more than 8,000 individuals (Fitzgerald et al. 2015, Angeli et al. 2018). These estimates are based on modeling and survey results conducted up to October 2015 (Angeli et al. 2018). Additional surveys are being conducted in Buck Island during 2019 by the National Park Service (USFWS, 2019b)

Threats and Stressors

Stressor: Introduced mongoose (USFWS, 1984)
Exposure:
Response:
Consequence:
Narrative: There is circumstantial evidence that correlates the decline of A. polops with the proliferation of the small Indian mongoose (USFWS, 1984).

Stressor: beautification' measures (USFWS, 1984)
Exposure:
Response:
Consequence:
Narrative: Modification of understory such as constant raking, removal of undergrowth and other 'beautification' projects around resorts and other developments may have contributed to the decline of the ground lizard (USFWS, 1984).

Recovery

Reclassification Criteria:
The recovery plan (USFWS, 1984) is outdated as it only lists criteria for reclassification but not delisting (USFWS, 2013).

The RP establishes that this species could be considered for reclassification from endangered to threatened when: 1. The existing population at Green Cay is protected. 2. The continued existence of the population on Protestant Cay is·ensured. 3. A self-sustaining population (500 or more individuals) is established on Buck Island. 4. Adequate population dispersion is obtained (USFWS, 2019).

Delisting Criteria:
The SCGL will be considered for delisting when the following criteria are met: 1. Establish two (2) additional populations that show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor C, and E). 2. Existing three (4) populations on Buck Island, Protestant Cay, Ruth Cay, and Green Cay show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor A, C, and E). 3. Threats have been addressed and/or managed to the extent that the species will remain viable into the foreseeable future (addresses Factor A, and C) (USFWS, 2019).

Recovery Actions:
- Evaluate success of translocation efforts to Bick Island and continue translocation if necessary to establish a self-sustainable population (USFWS, 2013).
- Initiate and/or continue rat and mongoose monitoring and control/eradication programs (USFWS, 2013).
- Initiate and/or continue habitat enhancement practices including invasive plant species removal and planting of native coastal vegetation (USFWS, 2013).
- Plan for a reverse translocation of lizards from Ruth to Protestant Cay as suggested by Hurtado et al. (2012), and assess other possible reverse translocations (USFWS, 2013).
- Protect Ruth Cay in perpetuity (USFWS, 2013).

- Assess climate change and sea level rise on lizard population and habitat (USFWS, 2013).
- Explore other possible reintroduction sites and/or translocations for the long-term survival of the species (USFWS, 2013).
- Update recovery plan and revise downlisting/delisting criteria (USFWS, 2013).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Implement a habitat management plan with Hotel on the Cay and VIDPNR, including recommendations to avoid and minimize potential effects on the species and its critical habitat from post-hurricane debris management. 2. Continue efforts to improve habitat in all areas, including control or eradication measures of rats. 3. Assess the species and its habitat vulnerability to climate change and sea-level rise. 4. Continue to implement the standard and systematic population survey protocol. 5. Assess strategies for the introduction of new populations elsewhere using translocations. 6. Study the effects of rats and green iguanas if necessary. (USFWS, 2019)

References

U.S. Fish and Wildlife Service. 1984. St. Croix Ground Lizard Recovery Plan, U.S. Fish and Wildlife Service, Atlanta, Georgia. 26 pp

U.S. Fish and Wildlife Service. 2013. St. Croix Ground Lizard (Ameiva polops) 5-Year Review: Summary and Evaluation U.S. Fish and Wildlife Service Southeast Region Caribbean Ecological Services Field Office Boqueron, Puerto Rico.

U.S. Fish and Wildlife Service. 1977. Endangered and Threatened Wildlife and Plants. Correction and Augmentation of Published Rulemaking. Final rule. 42 FR 47840 - 47845 (September 22, 1977).

U.S. Fish and Wildlife Service. 2013. St. Croix Ground Lizard (Ameiva polops) 5-Year Review: Summary and Evaluation U.S. Fish and Wildlife Service Southeast Region Caribbean Ecological Services Field Office Boqueron, Puerto Rico. USFWS. 2019b. St. Croix Ground Lizard (Ameiva polops) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Southeast Region Caribbean Ecological Services Field Office Boquerón, Puerto Rico. 29 pp.

U.S. Fish and Wildlife Service. 2019. Amendment 1 to the Recovery Plan for the endangered St. Croix ground lizard (Ameiva polops).

USFWS. 2013. St. Croix Ground Lizard (Ameiva polops)

5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Southeast Region, Caribbean Ecological Services Field Office, Boquerón, Puerto Rico. 19 pp.

USFWS. 2019b. St. Croix Ground Lizard (Ameiva polops) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Southeast Region Caribbean Ecological Services Field Office Boquerón, Puerto Rico. 29 pp.

SPECIES ACCOUNT: *Anolis roosevelti* (Culebra Island giant anole)

Species Taxonomic and Listing Information

Listing Status: Extinct (USFWS, 2023)

Physical Description

The Culebra Island 'Giant' anole, Anolis roosevelti, a rather large brownish-gray lizard growing about 160 mm snout-vent-length (USFWs, 1982).

Taxonomy

Despite the lack of any significant series of specimens, Major Grant was quite certain that the specimen he possessed represented a new taxon. The type description contains a comparison of this new species with both A. cuvieri for the mainland of Puerto Rico and A. ricordi from the Island of Hispaniola. It is evident from this comparison that the new species possesses characteristics of both of these species of giant anoles, but that it is distinct from either (USFWS, 1982). In 2015, Revell et al. (entire) published a study that investigated the phylogenetic position of Anolis roosevelti using the species' morphological characteristics and evolutionary correlations with extant species. Anolis roosevelti was placed in the phylogenetic tree of Greater Antillean Anolis lizards, finding that A. roosevelti is a sister lineage to A. equestris, a clade of morphologically and ecologically similar species commonly known as the Cuban crown-giant anole, which is currently found in Cuba. The results suggest that A. roosevelti is most likely not closely related to the clade containing most other Puerto Rican anole species (e.g., A. cuvieri, Revell et al. 2015, p. 1028, 1033). Although the Service recognizes the possibility of a change of phylogenetic position for the species, A. roosevelti is still considered a valid taxon and it does not impact our assessment of the species status described below (USFWS, 2023).

Historical Range

Culebra Island (USFWS, 1982).

Current Range

Culebra Island (USFWS, 2014).

Distinct Population Segments Defined

No

Critical Habitat Designated

Yes; 7/21/1977.

Legal Description

On July 21, 1977, the U.S. Fish and Wildlife Service designated critical habitat for Anolis roosevelti (Culebra Island giant anole) under the Endangered Species Act of 1973, as amended (42 FR 37371 - 37373).

Critical Habitat Designation

Critical habitat for the Culebra Island giant anole is designated in an area on Culebra Island outlined on the map depicted in the final rule.

Primary Constituent Elements/Physical or Biological Features

Not available

Special Management Considerations or Protections

The areas (exclusive of existing manmade structures or settlements which are not necessary to the normal needs or survival of the species) are Critical Habitat for the Species indicated. Pursuant to Section 7 of the Act, all Federal agencies must insure that actions authorized, funded, or carried out by them do not result-in the destruction or adverse modifkation of these areas.

Life History

Feeding Narrative

Adult: Unknown. Species has not been seen since 1932 and is only known from two preserved specimens (USFWS, 2014).Anectodal: Ficus fruit (USFWS, 1982)

Reproduction Narrative

Adult: Unknown. Species has not been seen since 1932 and is only known from two preserved specimens (USFWS, 2014).

Habitat Narrative

Adult: Anecdotal reports indicate this species may be arboreal and is found in Ficus and gumbo-limbo forests (USFWS, 1982).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Unknown. Species has not been seen since 1932 and is only known from two preserved specimens (USFWS, 2014).

Population Information and Trends

Population Trends:

Not available

Population Narrative:

Unknown. Species has not been seen since 1932 and is only known from two preserved specimens (USFWS, 2014).   The best scientific and commercial information lead the Service to conclude that the Culebra Island giant anole is extinct (USFWS, 2023).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Deforestation for residential and tourist development projects is considered an imminent threat to its survival. However, this threat is considered low in scale as most habitat is under protected status (USFWS, 2014).

Stressor: Catastrophic events and human-induced fires (2014)
Exposure:
Response:
Consequence:
Narrative: Catastrophic natural events such as hurricanes, may dramatic ally affect forest species composition and structure, felling large trees and creating numerous canopy gaps. Furthermore, fire is not a natural component of subtropical dry forest in Puerto Rico and Virgin Islands. Hence, species found in this type of habitats are not fire adapted, so human-induced fires constitute a threat the Culebra giant anole and its habitat (USFWS, 2014).

Recovery

Reclassification Criteria:
Confirm species existence (USFWS, 2014)

Recovery Priority Number: 17

Recovery Actions:

- If existent, the Culebra giant anole and its habitat may be threatened by modification, and manmade and natural catastrophic events. Therefore, as proposed by some researchers, more intensive and comprehensive surveys should be conducted to verify the status of the species (USFWS, 2014).

References

U.S. Fish and Wildlife Service. 1982. Giant Anole Recovery Plan, U.S. Fish and Wildlife Service, Atlanta, Georgia. 19 pp

U.S. Fish and Wildlife Service. 2014. Culebra Island Giant Anole (Anolis roosevelti) 5-Year Review: Summary and Evaluation U.S. Fish and Wildlife Service Southeast Region Caribbean Ecological Services Field Office Boqueron, Puerto Rico. USFWS. 2023. Culebra Island Giant Anole (Anolis roosevelti) 5-Year Review: Summary and Evaluation. Southeast Region. Caribbean Ecological Services Field Office. Boquerón, Puerto Rico. 20 pp.

U.S. Fish and Wildlife Service. 1977. Endangered and Threatened Wildlife and Plants

Final Endangered Status and Critical Habitat for the giant Anole. Final rule. 42 FR 37371 - 37373 (July 21, 1977).

U.S. Fish and Wildlife Service. 2014. Culebra Island Giant Anole (Anolis roosevelti) 5-Year Review: Summary and Evaluation U.S. Fish and Wildlife Service Southeast Region Caribbean Ecological Services Field Office Boqueron, Puerto Rico.

USFWS. 2014. Culebra Island Giant Anole (Anolis roosevelti)

5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Southeast Region, Caribbean Ecological Services Field Office, Boquerón, Puerto Rico. 21 pp.

SPECIES ACCOUNT: *Chelonia mydas* (Green sea turtle (Central S Pacific DPS))

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/06/2016; Pacific Region (R1) (USFWS, 2016a)

Physical Description

The green sea turtle grows to a maximum size of about 4 feet and a weight of 440 pounds. It has a heart-shaped shell, small head, and single-clawed flippers. Color is variable. Hatchlings generally have a black carapace, white plastron, and white margins on the shell and limbs. The adult carapace is smooth, keelless, and light to dark brown with dark mottling; the plastron is whitish to light yellow. Adult heads are light brown with yellow markings. Identifying characteristics include four pairs of costal scutes, none of which borders the nuchal scute, and only one pair of prefrontal scales between the eyes (USFWS, 2016a). The green sea turtle is globally distributed and commonly inhabits nearshore and inshore waters. The Central South Pacific DPS green turtle is found in the South Pacific Ocean throughout several island groups. The green sea turtle is the largest of the hardshell marine turtles, growing to a weight of 350 pounds (159 kilograms) and a straight carapace length of greater than 3.3 feet (1 meter) (NMFS Chlorpyrifos, Diazinon, and Malathion BiOp, 2017).

Taxonomy

The green turtle was first described by Linnaeus in 1758 as Testudo mydas, with Ascension Island in the Atlantic as the type locality. Schweigger in 1812 first applied the binomial Chelonia mydas in use today. The current taxonomic status of the green turtle is uncertain. Mitochondrial DNA research conducted by Bowen et al. (1992) showed a fundamental phylogenetic split distinguishing all green turtles in the Atlantic-Mediterranean from those in the Indian-Pacific Oceans. The shallow evolutionary structure of Chelonia populations within ocean basins likely resulted from extinction and colonization of rookeries over time-frames that are short by evolutionary standards, but long by ecological standards (Bowen et al. 1992). Consequently, in terms of conservation and management, the available evidence indicates that breeding sites must be considered as demographically independent units (NMFS and USFWS, 1998).

Historical Range

The present distribution of the breeding sites has been largely affected by historical patterns of human exploitation. Most of the substantial breeding colonies left today are those that have not been permanently inhabited by humans or have not been heavily exploited until recently (Groombridge and Luxmoore 1989, Seminoff 2004) (NMFS and USFWS, 2007).

Current Range

The range of the DPS extends north and east of New Zealand to include a longitudinal expanse of 7,500 km, from Easter Island, Chile in the east to Fiji in the west, and encompasses American Samoa, French Polynesia, Cook Islands, Fiji, Kiribati, Tokelau, Tonga, and Tuvalu. Its open ocean polygonal boundary endpoints are (clockwise from the northwest-most extent): 9° N., 175° W. to 9° N., 125° W. to 40° S., 96° W. to 40° S., 176° E., to 13° S., 171° E., and back to 9° N., 175° W (USFWS, 2016b). (NMFS Chlorpyrifos, Diazinon, and Malathion BiOp, 2017). The green turtle has a circumglobal distribution, occurring throughout nearshore tropical, subtropical and, to a lesser extent, temperate waters. The Southwest Pacific DPS extends off the eastern coast of Australia, south of Papua New Guinea and goes east to encompass Vanuatu and New Caledonia. Major nesting sites for the DPS include the Great Barrier Reef, eastern Torres Strait and the northern Great Barrier Reef. Nesting also occurs in New Caledonia, Vanuatu and the Coral Sea Islands (NMFS Chlorpyrifos, Diazinon, and Malathion BiOp, 2017).

Distinct Population Segments Defined

Central South Pacific

Critical Habitat Designated

No;

Life History

Feeding Narrative

Juvenile: Hatchling green turtles eat a variety of plants and animals (USFWS, 2016a). The diets of post-hatchlings and juveniles living in pelagic habitats appear to be entirely carnivorous (e.g., invertebrates and fish eggs), but records are only known from the occasional turtles encountered (NMFS and USFWS, 1998). Growth rates of juveniles vary substantially between populations, ranging from < 1 cm/year (Green 1993) to > 5 cm/year (NMFS and USFWS, 2007).

Adult: Adults feed almost exclusively on seagrasses and marine algae (USFWS, 2016a). Green turtles consume invertebrates such as jellyfish, sponges, sea pens, and pelagic prey. Most green turtles exhibit slow growth rates (NMFS and USFWS, 2007). Foraging on marine vegetation occurs in benthic habitats (NMFS and USFWS, 1998).

Reproduction Narrative

Adult: Open beaches with a sloping platform and minimal disturbance are required for nesting. Nesting occurs nocturnally at 2, 3, or 4-year intervals. Only occasionally do females produce clutches in successive years. A female may lay as a many as nine clutches within a nesting season (overall average is about 3.3 nests per season) at about 13-day intervals. Clutch size varies from 75 to 200 eggs. Incubation ranges from about 45 to 75 days, depending on incubation temperatures. Age at sexual maturity is believed to be 20 to 50 years (USFWS, 2016a). There is little diversity of nesting sites, with most nesting occurring on low-lying coral atolls or oceanic islands (USFWS, 2016b). Estimates of reproductive longevity range from 17 - 23 years. A female may deposit 900 - 3,300 eggs during a lifetime. There is an increasing female bias in the sex ratio of hatchlings. Healthy beaches have intact dune structures and native vegetation, which maintain normal beach temperatures (NMFS and USFWS, 2007). Age at first reproduction for females is twenty to forty years. Green sea turtles lay an average of three nests per season with an average of one hundred eggs per nest. The remigration interval (i.e., return to natal beaches) is two to five years. Nesting occurs primarily on beaches with intact dune structure, native vegetation and appropriate incubation temperatures during summer months. After emerging from the nest, hatchlings swim to offshore areas and go through a post-hatchling pelagic stage where they are believed to live for several years. During this life stage, green sea turtles feed close to the surface on a variety of marine algae and other life associated with drift lines and debris. Adult turtles exhibit site fidelity and migrate hundreds to thousands of kilometers from nesting beaches to foraging areas. Green sea turtles spend the majority of their lives in coastal foraging grounds, which include open coastlines and protected bays and lagoons.

Adult green turtles feed primarily on seagrasses and algae, although they also eat jellyfish, sponges and other invertebrate prey (NMFS Chlorpyrifos, Diazinon, and Malathion BiOp, 2017).

Site Fidelity

Adult: High (USFWS, 2016a; see dispersal/migration narrative)

Dependency on Other Individuals or Species for Habitat

Juvenile: Sargassum spp. (USFWS, 2016a)

Habitat Narrative

Juvenile: Hatchlings have been observed to seek refuge and food in Sargassum rafts (USFWS, 2016a).

Adult: Green turtles are generally found in fairly shallow waters (except when migrating) inside reefs, bays, and inlets. The turtles are attracted to lagoons and shoals with an abundance of marine grass and algae (USFWS, 2016a). In addition to coastal foraging areas, oceanic habits are used by oceanic-stage juveniles, migrating adults, and turtles that reside in the oceanic zone for foraging (NMFS and USFWS, 2007).

Dispersal/Migration

Motility/Mobility

Juvenile: High (inferred form NMFS and USFWS, 1998)

Adult: High (USFWS, 2016a)

Migratory vs Non-migratory vs Seasonal Movements

Adult: Migratory (USFWS, 2016a)

Dispersal

Juvenile: High (inferred form NMFS and USFWS, 1998)

Adult: High (USFWS, 2016a)

Immigration/Emigration

Juvenile: Emigrates from nesting beach (NMFS and USFWS, 1998)

Dispersal/Migration Narrative

Juvenile: The pelagic movements of post-hatchling and young juveniles are undocumented. The proper dispersal of hatchlings by ocean currents off a particular nesting beach may be a crucial factor (Collard and Ogren 1990) (NMFS and USFWS, 1998).

Adult: Green turtles apparently have a strong nesting site fidelity and often make long distance migrations between feeding grounds and nesting beaches (USFWS, 2016a).

Population Information and Trends

Population Trends:

Not available

Species Trends:
Varied (USFWS, 2016b)

Number of Populations:
1; 59 nesting sites (USFWS, 2016b)

Population Size:
2,677 - 3,600 nesting females annually (USFWS, 2016b)

Resistance to Disease:
Low (inferred from NMFS and USFWS, 2007; see threats)

Population Narrative:
The DPS exhibits low nesting abundance, with an estimated total nester abundance of 2,677 to 3,600 nesting females at 59 nesting sites. There is a negative nesting trend at the most abundant nesting site but increasing trends at less abundant nesting beaches. There are at least two genetic stocks within the DPS. Nesting is geographically broad (USFWS, 2016b). Historically, the Central South Pacific DPS declined due to harvest of eggs and females for human consumption or for their shells, a practice that still continues throughout the region. Incidental bycatch in commercial and artisanal fishing gear, lack of regulatory mechanisms and climate change are significant threats to the long-term viability of the DPS (NMFS Chlorpyrifos, Diazinon, and Malathion BiOp, 2017). Abundance Worldwide, nesting data at 464 sites indicate that 563,826 to 564,464 females nest each year. Nesting abundance information for the Central South Pacific DPS is limited, but is considered to be at low levels and spread out over a large geographic area. There are 59 known nesting sites (22 are unquantified), with an estimated 2,677 nesting females. The largest nesting site is at Scilly Atoll in French Polynesia, which hosts 36% of the nesting females for the DPS (Seminoff et al. 2015). Productivity / Population Growth Rate There are no estimates of population growth for the Central South Pacific DPS. The DPS suffers from a lack of consistent, systematic nesting monitoring, with no nesting site having even five years of continuous data. What data are available indicate steep declines at Scilly Atoll due to illegal harvest, with some smaller nesting sites (e.g., Rose Atoll) showing signs of stability (Seminoff et al. 2015). Genetic Diversity There is very limited information available for the Central South Pacific DPS. Mitochondrial DNA studies indicate at least two genetic stocks in the DPS—American Samoa and French Polynesia. Overall, there is a moderate level of diversity for the DPS, and the presence of unique haplotypes (Seminoff et al. 2015) (NMFS Chlorpyrifos, Diazinon, and Malathion BiOp, 2017).

Threats and Stressors

Stressor: Degradation of nesting habitat (USFWS, 2016b)
Exposure:
Response:
Consequence:
Narrative: Some nesting beaches are degraded by coastal erosion, development, construction, sand extraction, artificial lighting, proximity to road traffic, and natural disasters, such as tsunamis (USFWS, 2016b).

Stressor: Degradation of marine habitat (USFWS, 2016b)
Exposure:
Response:
Consequence:
Narrative: Marine habitat is degraded by runoff, sedimentation, dredging, ship groundings, natural disasters, and pollution (e.g., oil spills, toxic and industrial wastes, and heavy metals). Injury and mortality result from the entanglement in and ingestion of plastics, monofilament fishing line, and other marine debris (e.g., Wedemeyer-Strombel et al., 2015) (USFWS, 2016b).

Stressor: Harvest/bycatch (USFWs, 2016b)
Exposure:
Response:
Consequence:
Narrative: Commercial and traditional exploitation of turtles and eggs has resulted in declines at the most abundant nesting site and other locations. Illegal harvest of turtles and eggs is also a major threat. Incidental capture in artisanal and commercial fisheries (e.g., line, trap, and net fisheries) is a significant threat to the DPS. The primary gear types involved in these interactions include longlines, traps, and nets (USFWS, 2016b).

Stressor: Predation (USFWS, 2016b)
Exposure:
Response:
Consequence:
Narrative: Predation by introduced species is a significant threat in some areas (USFWS, 2016b).

Stressor: Climate change (USFWS, 2016b)
Exposure:
Response:
Consequence:
Narrative: Islands within the South Pacific are especially vulnerable to sea level rise, which together with increasing storm events, is likely to reduce available nesting habitat (USFWS, 2016b).

Stressor: Fibropapillomatosis (NMFS and USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: This disease is characterized by the presence of internal and/or external tumors that may grow large enough to hamper swimming, vision, feeding, and potential escape from predators (Herbst 1994). For unknown reasons, the frequency of FP is much higher in green turtles than in other species. The population-level impacts of this disease are not yet understood (NMFS and USFWS, 2007).

Stressor: Inadequacy of existing regulatory mechanisms (NMFS and USFWS, 2007)
Exposure:
Response:
Consequence:

Narrative: The conservation and recovery of sea turtles, and green turtles particularly, is facilitated by a number of regulatory instruments at international, regional, national, and local levels. Despite these advances, human impacts continue throughout the world. The lack of comprehensive and effective monitoring and bycatch reduction efforts in many pelagic and near-shore fisheries operations still allows substantial direct and indirect mortality, and the uncontrolled development of coastal and marine habitats threatens to destroy the supporting ecosystems of long-lived green turtles. Although several international agreements provide legal protection for sea turtles, additional multi-lateral efforts are needed to ensure they are sufficiently implemented and/or strengthened, and key non-signatory parties need to be encouraged to accede (NMFS and USFWS, 2007).

Recovery

Reclassification Criteria:
Not available

Delisting Criteria:
1. All regional stocks that use U.S. waters have been identified to source beaches based on reasonable geographic parameters (NMFS and USFWS, 1998).

2. Each stock must average 5,000 (or a biologically reasonable estimate based on the goal of maintaining a stable population in perpetuity) females estimated to nest annually (FENA) over six years NMFS and USFWS, 1998).

3. Nesting populations at "source beaches" are either stable or increasing over a 25-year monitoring period (NMFS and USFWS, 1998).

4. Existing foraging areas are maintained as healthy environments (NMFS and USFWS, 1998).

5. Foraging populations are exhibiting statistically significant increases at several key foraging grounds within each stock region (NMFS and USFWS, 1998).

6. All Priority #1 tasks have been implemented (NMFS and USFWS, 1998).

7. A management plan to maintain sustained populations of turtles is in place (NMFS and USFWS, 1998).

Recovery Actions:
- Eliminate the threat of fibropapillomas to green turtle populations (NMFS and USFWS, 1998).
- Reduce incidental harvest of green turtles by commercial and artisanal fisheries (NMFS and USFWS, 1998).
- Determine population size and status through regular nesting beach and in-water censuses (NMFs and USFWS, 1998).
- Identify stock home ranges using DNA analysis (NMFS and USFWS, 1998).
- Support conservation and biologically viable management of green turtle populations in countries that share U.S. green turtle stocks (NMFS and USFWS, 1998).

- Identify and protect primary nesting and foraging areas for the species (NMFS and USFWS, 1998).
- Eliminate adverse effects of development on green turtle nesting and foraging habitats (NMFS and USFWS, 1998).
- Control non-native predators of eggs and hatchlings, e.g., mongoose, feral cats, and pigs, in the Hawaiian population (NMFS and USFWS, 1998).
- Stop the direct harvest of green sea turtles and eggs, through education and law enforcement actions (NMFS and USFWS, 1998).
- Preliminary information indicates an analysis and review of the species should be conducted in the future to determine the application of the DPS policy to the green turtle. Since the species' listing, a substantial amount of information has become available on population structure (through genetic studies) and distribution (through telemetry, tagging, and genetic studies). The Service has not yet fully assembled or analyzed this new information; however, at a minimum, these data appear to indicate a possible separation of populations by ocean basins. To determine the application of the DPS policy to the green turtle, the Services intend to fully assemble and analyze this new information in accordance with the DPS policy (NMFS and USFWS, 2007).
- The current "Recovery Plan for U.S. Population of Atlantic Green Turtle (Chelonia mydas)" was completed in 1991, the "Recovery Plan for U.S. Pacific Populations of the Green Turtle (Chelonia mydas)" was completed in 1998, and the "Recovery Plan for U.S. Pacific Populations of the East Pacific Green Turtle (Chelonia mydas)" was completed in 1998. The recovery criteria contained in the plans, while not strictly adhering to all elements of the 2004 NMFS Interim Recovery Planning Guidance, are a viable measure of the species status. The species biology, demographic trends, and population status information can be updated where appropriate; however, the recovery actions identified in the plans are appropriate and properly prioritized. While some additional recovery actions can no doubt be identified, the Service believe that the current plans remain valid conservation planning tools. The recovery plans should be re-examined over the next 5 - 10 year horizon, particularly if the DPS analysis results in restructuring of the current listing. To update the plans to conform to the 2004 NMFS Interim Recovery Planning Guidance. In the near-term, additional information and data are particularly needed on genetic relationships among nesting populations, impacts of coastal and pelagic fisheries, foraging areas and identification of threats at foraging areas, and long-term population trends (NMFS and USFWS, 2007).
- Conservation efforts throughout the region, such as establishment of protected areas and national legislation to protect turtles, provide some benefits to the DPS. The remoteness of some areas appears to provide the most conservation protection against certain threats, such as poaching (USFWS, 2016b).

References

USFWS. 2016a. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/ecp0/. Accessed September 2016

USFWS 2016b. Endangered and Threatened Wildlife and Plants

Final Rule To List Eleven Distinct Population Segments of the Green Sea Turtle (Chelonia mydas) as Endangered or Threatened and Revision of Current Listings Under the Endangered Species Act. 81

Federal Register 66. April 6, 2016. Pages 20057 - 20090

NMFS and USFWS 2007. Green Sea Turtle (Chelonia mydas) 5-Year Review: Summary and Evaluation. National Marine Fisheries Service Office of Protected Resources Silver Spring, Maryland and U.S. Fish and Wildlife Service Southeast Region Jacksonville Ecological Services Field Office Jacksonville, Florida. August 2007

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1998. Recovery Plan for U.S. Pacific Populations of the Green Turtle (Chelonia mydas). National Marine Fisheries Service, Silver Spring, MD.

National Marine Fisheries Service. 2017. Biological Opinion on the Environmental Protection Agency's Registration of Pesticides containing Chlorpyrifos, Diazinon, and Malathion. Consultation Tracking number: FPR-2017-9241. Digital Object Identifier (DOI): https://doi.org/10.7289/V5CJ8BQM

USFWS. 2016b. Endangered and Threatened Wildlife and Plants

Final Rule To List Eleven Distinct Population Segments of the Green Sea Turtle (Chelonia mydas) as Endangered or Threatened and Revision of Current Listings Under the Endangered Species Act. 81 Federal Register 66. April 6, 2016. Pages 20057 - 20090.

NMFS and USFWS 2007. Green Sea Turtle (Chelonia mydas) 5-Year Review: Summary and Evaluation. National Marine Fisheries Service Office of Protected Resources Silver Spring, Maryland and U.S. Fish and Wildlife Service Southeast Region Jacksonville Ecological Services Field Office Jacksonville, Florida. August 2007.

NMFS and USFWS 2007. Green Sea Turtle (Chelonia mydas) 5-Year Review: Summary and Evaluation. National Marine Fisheries Service Office of Protected Resources Silver Spring, Maryland and U.S. Fish and Wildlife Service Southeast Region Jacksonville Ecological Services Field Office, Jacksonville, Florida. August 2007.

SPECIES ACCOUNT: *Chelonia mydas* (Green sea turtle (Central W Pacific DPS))

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/06/2016; Pacific Region (R1) (USFWS, 2016)

Physical Description

The green sea turtle grows to a maximum size of about 4 feet and a weight of 440 pounds. It has a heart-shaped shell, small head, and single-clawed flippers. Color is variable. Hatchlings generally have a black carapace, white plastron, and white margins on the shell and limbs. The adult carapace is smooth, keelless, and light to dark brown with dark mottling; the plastron is whitish to light yellow. Adult heads are light brown with yellow markings. Identifying characteristics include four pairs of costal scutes, none of which borders the nuchal scute, and only one pair of prefrontal scales between the eyes (USFWS, 2016a). The green sea turtle is globally distributed and commonly inhabits nearshore and inshore waters. The Central West Pacific DPS green turtle is found in the Pacific Ocean near Papua New Guinea, and West Papua, Indonesia. The green sea turtle is the largest of the hardshell marine turtles, growing to a weight of 350 pounds (159 kilograms) and a straight carapace length of greater than 3.3 feet (1 meter) (NMFS Chlorpyrifos, Diazinon, and Malathion BiOp, 2017).

Taxonomy

The green turtle was first described by Linnaeus in 1758 as Testudo mydas, with Ascension Island in the Atlantic as the type locality. Schweigger in 1812 first applied the binomial Chelonia mydas in use today. The current taxonomic status of the green turtle is uncertain. Mitochondrial DNA research conducted by Bowen et al. (1992) showed a fundamental phylogenetic split distinguishing all green turtles in the Atlantic-Mediterranean from those in the Indian-Pacific Oceans. The shallow evolutionary structure of Chelonia populations within ocean basins likely resulted from extinction and colonization of rookeries over time-frames that are short by evolutionary standards, but long by ecological standards (Bowen et al. 1992). Consequently, in terms of conservation and management, the available evidence indicates that breeding sites must be considered as demographically independent units (NMFS and USFWS, 1998).

Historical Range

The present distribution of the breeding sites has been largely affected by historical patterns of human exploitation. Most of the substantial breeding colonies left today are those that have not been permanently inhabited by humans or have not been heavily exploited until recently (Groombridge and Luxmoore 1989, Seminoff 2004) (NMFS and USFWS, 2007).

Current Range

The range of the Central West Pacific DPS has a northern boundary of 41° N. latitude and is bounded by 41° N., 169° E. in the northeast corner, going southeast to 9° N., 175° W., then southwest to 13° S., 171° E., west and slightly north to the eastern tip of Papua New Guinea, along the northern shore of the Island of New Guinea to West Papua in Indonesia, northwest to 4.5° N., 129° E. then to West Papua in Indonesia, then north to 41° N., 146° E. It encompasses the Republic of Palau, Federated States of Micronesia, New Guinea, Solomon Islands, Marshall Islands, Guam, CNMI, and the Ogasawara Islands of Japan (USFWS, 2016b). The species was separated into two listing designations: endangered for breeding populations in Florida and the Pacific coast of Mexico and threatened in all other areas throughout its range (NMFS Chlorpyrifos, Diazinon, and Malathion BiOp, 2017). The green turtle has a circumglobal distribution, occurring throughout nearshore tropical, subtropical and, to a lesser extent, temperate waters. The Central West Pacific DPS is composed of nesting assemblages in the Federated States of Micronesia, the Japanese islands of Chichijima and Hahajima, the Marshall Islands, and Palau. Green turtles in this DPS are found throughout the western Pacific Ocean, in Indonesia, the Philippines, the Marshall Islands and Papua New Guinea (NMFS Chlorpyrifos, Diazinon, and Malathion BiOp, 2017)

Distinct Population Segments Defined

Central West Pacific

Critical Habitat Designated

No;

Life History

Feeding Narrative

Juvenile: Hatchling green turtles eat a variety of plants and animals (USFWS, 2016a). The diets of post-hatchlings and juveniles living in pelagic habitats appear to be entirely carnivorous (e.g., invertebrates and fish eggs), but records are only known from the occasional turtles encountered (NMFS and USFWS, 1998). Growth rates of juveniles vary substantially between populations, ranging from < 1 cm/year (Green 1993) to > 5 cm/year (NMFS and USFWS, 2007).

Adult: Adults feed almost exclusively on seagrasses and marine algae (USFWS, 2016a). Green turtles consume invertebrates such as jellyfish, sponges, sea pens, and pelagic prey. Most green turtles exhibit slow growth rates (NMFS and USFWS, 2007). Foraging on marine vegetation occurs in benthic habitats (NMFS and USFWS, 1998).

Reproduction Narrative

Adult: Open beaches with a sloping platform and minimal disturbance are required for nesting. Nesting occurs nocturnally at 2, 3, or 4-year intervals. Only occasionally do females produce clutches in successive years. A female may lay as a many as nine clutches within a nesting season (overall average is about 3.3 nests per season) at about 13-day intervals. Clutch size varies from 75 to 200 eggs. Incubation ranges from about 45 to 75 days, depending on incubation temperatures. Age at sexual maturity is believed to be 20 to 50 years (USFWS, 2016a). Nesting is relatively widespread but occurs only on islands and atolls (i.e., little nesting site diversity) (USFWS, 2016b). Estimates of reproductive longevity range from 17 - 23 years. A female may deposit 900 - 3,300 eggs during a lifetime. There is an increasing female bias in the sex ratio of hatchlings. Healthy beaches have intact dune structures and native vegetation, which maintain normal beach temperatures (NMFS and USFWS, 2007). Age at first reproduction for females is twenty to forty years. Green sea turtles lay an average of three nests per season with an average of one hundred eggs per nest. The remigration interval (i.e., return to natal beaches) is two to five years. Nesting occurs primarily on beaches with intact dune structure, native vegetation and appropriate incubation temperatures during summer months. After emerging from the nest, hatchlings swim to offshore areas and go through a post-hatchling pelagic stage where they are believed to live for several years. During this life stage, green sea turtles feed close to the surface on a variety of marine algae and other life associated with drift lines and debris. Adult turtles exhibit site fidelity and migrate hundreds to thousands of kilometers from nesting beaches to foraging areas. Green sea turtles spend the majority of their lives in coastal foraging grounds, which include open coastlines and protected bays and lagoons. Adult green turtles feed primarily on seagrasses and algae, although they also eat jellyfish, sponges and other invertebrate prey (NMFS Chlorpyrifos, Diazinon, and Malathion BiOp, 2017).

Site Fidelity

Adult: High (USFWS, 2016a; see dispersal/migration narrative)

Dependency on Other Individuals or Species for Habitat

Juvenile: Sargassum spp. (USFWS, 2016a)

Habitat Narrative

Juvenile: Hatchlings have been observed to seek refuge and food in Sargassum rafts (USFWS, 2016a).

Adult: Green turtles are generally found in fairly shallow waters (except when migrating) inside reefs, bays, and inlets. The turtles are attracted to lagoons and shoals with an abundance of marine grass and algae (USFWS, 2016a). In addition to coastal foraging areas, oceanic habits are used by oceanic-stage juveniles, migrating adults, and turtles that reside in the oceanic zone for foraging (NMFS and USFWS, 2007).

Dispersal/Migration

Motility/Mobility

Juvenile: High (inferred form NMFS and USFWS, 1998)

Adult: High (USFWS, 2016a)

Migratory vs Non-migratory vs Seasonal Movements

Adult: Migratory (USFWS, 2016a)

Dispersal

Juvenile: High (inferred form NMFS and USFWS, 1998)

Adult: High (USFWS, 2016a)

Immigration/Emigration

Juvenile: Emigrates from nesting beach (NMFS and USFWS, 1998)

Dispersal/Migration Narrative

Juvenile: The pelagic movements of post-hatchling and young juveniles are undocumented. The proper dispersal of hatchlings by ocean currents off a particular nesting beach may be a crucial factor (Collard and Ogren 1990) (NMFS and USFWS, 1998).

Adult: Green turtles apparently have a strong nesting site fidelity and often make long distance migrations between feeding grounds and nesting beaches (USFWS, 2016a).

Population Information and Trends

Population Trends:
Not available

Species Trends:
Varied (USFWS, 2016b)

Number of Populations:
1; 50 nesting sites (USFWS, 2016b)

Population Size:
6,518 nesting females annually (USFWS, 2016b)

Resistance to Disease:
Low (inferred from NMFS and USFWS, 2007; see threats)

Population Narrative:
This DPS exhibits low nesting abundance, with an estimated total nester abundance of 6,518 females at 50 nesting sites. Nesting data indicate increasing trends at one site but decreasing trends at others (USFWS, 2016b). The Central West Pacific DPS is impacted by incidental bycatch in fishing gear, predation of eggs by ghost crabs and rats, and directed harvest eggs and nesting females for human consumption. Historically, intentional harvest of eggs from nesting beaches was one of the principal causes for decline, and this practice continues today in many locations. The Central West Pacific DPS has a small number of nesting females and a widespread geographic range. These factors, coupled with the threats facing the DPS and the unknown status of many nesting sites makes the DPS vulnerable to future perturbations (NMFS Chlorpyrifos, Diazinon, and Malathion BiOp, 2017). Abundance: Worldwide, nesting data at 464 sites indicate that 563,826 to 564,464 females nest each year. There are 51 nesting sites in the Central West Pacific DPS, with an estimated 6,518 nesting females. The largest nesting site is in the Federated States of Micronesia, which hosts 22% of the nesting females for the DPS (Seminoff et al. 2015). Productivity / Population Growth Rate: There are no estimates of population growth rates for the Central West Pacific DPS. Long-term nesting data is lacking for many of the nesting sites in the Central West Pacific DPS, making it difficult to assess population trends. The only site which as long-term data available—Chichijima, Japan—shows a positive trend in population growth (Seminoff et al. 2015). Genetic Diversity: The Central West Pacific DPS is made up of insular rookeries separated by broad geographic distances. Rookeries that are more than 1,000 km apart are significantly differentiated, while rookeries 500 km apart are not. Mitochondrial DNA analyses suggest that there are at least seven independent stocks in the region (Dutton et al. 2014) (NMFS Chlorpyrifos, Diazinon, and Malathion BiOp, 2017).

Threats and Stressors

Stressor: Degradation of nesting habitat (USFWS, 2016b)
Exposure:
Response:
Consequence:

Narrative: Nesting habitat is degraded by coastal development and construction, placement of barriers to nesting, beachfront lighting, tourism, vehicular and pedestrian traffic, sand extraction, beach erosion, beach pollution, removal of native vegetation, and the presence of non-native vegetation (USFWS, 2016b).

Stressor: Degradation of marine habitat (USFWS, 2016b)
Exposure:
Response:
Consequence:
Narrative: Destruction and modification of marine habitat occurs as a result of coastal construction, tourism, sedimentation, pollution, sewage, runoff, military activities, dredging, destructive fishing methods, and boat anchoring. Marine debris results in the mortality of sea turtles through ingestion and entanglement (USFWS, 2016b).

Stressor: Harvest/bycatch (USFWs, 2016b)
Exposure:
Response:
Consequence:
Narrative: The harvest of turtles and eggs is a large and persistent threat throughout the range of this DPS. Turtles are incidentally caught in longline, pole and line, and purse seine fisheries (USFWS, 2016b).

Stressor: Predation (USFWS, 2016b)
Exposure:
Response:
Consequence:
Narrative: Predation is a significant threat in some areas (USFWS, 2016b).

Stressor: Climate change (USFWS, 2016b)
Exposure:
Response:
Consequence:
Narrative: Temperature increases, as a result of climate change, are the greatest long-term threat to atoll morphology in nations throughout the range of this DPS. Sea level rise is likely to reduce available nesting habitat. The increased frequency and intensity of storm events are likely to cause beach erosion and nest inundation, as demonstrated in a recent study by Summers et al. (in progress) (USFWS, 2016b).

Stressor: Fibropapillomatosis (NMFS and USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: This disease is characterized by the presence of internal and/or external tumors that may grow large enough to hamper swimming, vision, feeding, and potential escape from predators (Herbst 1994). For unknown reasons, the frequency of FP is much higher in green turtles than in other species. The population-level impacts of this disease are not yet understood (NMFS and USFWS, 2007).

Stressor: Inadequacy of existing regulatory mechanisms (NMFS and USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: The conservation and recovery of sea turtles, and green turtles particularly, is facilitated by a number of regulatory instruments at international, regional, national, and local levels. Despite these advances, human impacts continue throughout the world. The lack of comprehensive and effective monitoring and bycatch reduction efforts in many pelagic and near-shore fisheries operations still allows substantial direct and indirect mortality, and the uncontrolled development of coastal and marine habitats threatens to destroy the supporting ecosystems of long-lived green turtles. Although several international agreements provide legal protection for sea turtles, additional multi-lateral efforts are needed to ensure they are sufficiently implemented and/or strengthened, and key non-signatory parties need to be encouraged to accede (NMFS and USFWS, 2007).

Recovery

Reclassification Criteria:
Not available

Delisting Criteria:
1. All regional stocks that use U.S. waters have been identified to source beaches based on reasonable geographic parameters (NMFS and USFWS, 1998).

2. Each stock must average 5,000 (or a biologically reasonable estimate based on the goal of maintaining a stable population in perpetuity) females estimated to nest annually (FENA) over six years NMFS and USFWS, 1998).

3. Nesting populations at "source beaches" are either stable or increasing over a 25-year monitoring period (NMFS and USFWS, 1998).

4. Existing foraging areas are maintained as healthy environments (NMFS and USFWS, 1998).

5. Foraging populations are exhibiting statistically significant increases at several key foraging grounds within each stock region (NMFS and USFWS, 1998).

6. All Priority #1 tasks have been implemented (NMFS and USFWS, 1998).

7. A management plan to maintain sustained populations of turtles is in place (NMFS and USFWS, 1998).

Recovery Actions:
- Eliminate the threat of fibropapillomas to green turtle populations (NMFS and USFWS, 1998).
- Reduce incidental harvest of green turtles by commercial and artisanal fisheries (NMFS and USFWS, 1998).
- Determine population size and status through regular nesting beach and in-water censuses (NMFs and USFWS, 1998).

- Identify stock home ranges using DNA analysis (NMFS and USFWS, 1998).
- Support conservation and biologically viable management of green turtle populations in countries that share U.S. green turtle stocks (NMFS and USFWS, 1998).
- Identify and protect primary nesting and foraging areas for the species (NMFS and USFWS, 1998).
- Eliminate adverse effects of development on green turtle nesting and foraging habitats (NMFS and USFWS, 1998).
- Control non-native predators of eggs and hatchlings, e.g., mongoose, feral cats, and pigs, in the Hawaiian population (NMFS and USFWS, 1998).
- Stop the direct harvest of green sea turtles and eggs, through education and law enforcement actions (NMFS and USFWS, 1998).
- Preliminary information indicates an analysis and review of the species should be conducted in the future to determine the application of the DPS policy to the green turtle. Since the species' listing, a substantial amount of information has become available on population structure (through genetic studies) and distribution (through telemetry, tagging, and genetic studies). The Service has not yet fully assembled or analyzed this new information; however, at a minimum, these data appear to indicate a possible separation of populations by ocean basins. To determine the application of the DPS policy to the green turtle, the Services intend to fully assemble and analyze this new information in accordance with the DPS policy (NMFS and USFWS, 2007).
- The current "Recovery Plan for U.S. Population of Atlantic Green Turtle (Chelonia mydas)" was completed in 1991, the "Recovery Plan for U.S. Pacific Populations of the Green Turtle (Chelonia mydas)" was completed in 1998, and the "Recovery Plan for U.S. Pacific Populations of the East Pacific Green Turtle (Chelonia mydas)" was completed in 1998. The recovery criteria contained in the plans, while not strictly adhering to all elements of the 2004 NMFS Interim Recovery Planning Guidance, are a viable measure of the species status. The species biology, demographic trends, and population status information can be updated where appropriate; however, the recovery actions identified in the plans are appropriate and properly prioritized. While some additional recovery actions can no doubt be identified, the Service believe that the current plans remain valid conservation planning tools. The recovery plans should be re-examined over the next 5 - 10 year horizon, particularly if the DPS analysis results in restructuring of the current listing. To update the plans to conform to the 2004 NMFS Interim Recovery Planning Guidance. In the near-term, additional information and data are particularly needed on genetic relationships among nesting populations, impacts of coastal and pelagic fisheries, foraging areas and identification of threats at foraging areas, and long-term population trends (NMFS and USFWS, 2007).

References

USFWS. 2016a. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/ecp0/. Accessed September 2016

USFWS 2016b. Endangered and Threatened Wildlife and Plants

Final Rule To List Eleven Distinct Population Segments of the Green Sea Turtle (Chelonia mydas) as Endangered or Threatened and Revision of Current Listings Under the Endangered Species Act. 81 Federal Register 66. April 6, 2016. Pages 20057 - 20090

NMFS and USFWS 2007. Green Sea Turtle (Chelonia mydas) 5-Year Review: Summary and Evaluation. National Marine Fisheries Service Office of Protected Resources Silver Spring, Maryland and U.S. Fish and Wildlife Service Southeast Region Jacksonville Ecological Services Field Office Jacksonville, Florida. August 2007

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1998. Recovery Plan for U.S. Pacific Populations of the Green Turtle (Chelonia mydas). National Marine Fisheries Service, Silver Spring, MD.

National Marine Fisheries Service. 2017. Biological Opinion on the Environmental Protection Agency's Registration of Pesticides containing Chlorpyrifos, Diazinon, and Malathion. Consultation Tracking number: FPR-2017-9241. Digital Object Identifier (DOI): https://doi.org/10.7289/V5CJ8BQM

USFWS. 2016b. Endangered and Threatened Wildlife and Plants

Final Rule To List Eleven Distinct Population Segments of the Green Sea Turtle (Chelonia mydas) as Endangered or Threatened and Revision of Current Listings Under the Endangered Species Act. 81 Federal Register 66. April 6, 2016. Pages 20057 - 20090.

NMFS and USFWS 2007. Green Sea Turtle (Chelonia mydas) 5-Year Review: Summary and Evaluation. National Marine Fisheries Service Office of Protected Resources Silver Spring, Maryland and U.S. Fish and Wildlife Service Southeast Region Jacksonville Ecological Services Field Office Jacksonville, Florida. August 2007.

NMFS and USFWS 2007. Green Sea Turtle (Chelonia mydas) 5-Year Review: Summary and Evaluation. National Marine Fisheries Service Office of Protected Resources Silver Spring, Maryland and U.S. Fish and Wildlife Service Southeast Region Jacksonville Ecological Services Field Office, Jacksonville, Florida. August 2007.

SPECIES ACCOUNT: *Chelonia mydas* (Green sea turtle (N Atlantic DPS))

Species Taxonomic and Listing Information

Listing Status: Threatened; Southeast Region (R4) (USFWS, 2015) 7/28/1978

Physical Description

A sea turtle with a brown carapace, often with radiating mottled or wavy dark markings or large dark brown blotches; 4 costal plates on each side of carapace; first costal does not contact the nuchal; one pair of prefrontal plates between the eyes; limbs are flattened flippers; young are black to dark brown above, mainly white below, with a mid-dorsal keel and two plastral keels, 4-6 cm at hatching; adult carapace length usually 90-122 cm (to 153 cm), mass 113-204 kg (to 295+ kg) (Conant and Collins 1991). LENGTH:122 WEIGHT: 200000 (NatureServe, 2015). The green sea turtle is the largest of the hardshell marine turtles, growing to a weight of 350 pounds (159 kilograms) and a straight carapace length of greater than 3.3 feet (1 meter). The species was listed under the ESA on July 28, 1978 (43 FR 32800) (NMFS Chlorpyrifos, Diazinon, and Malathion BiOp, 2017).

Taxonomy

Eastern Pacific populations of Chelonia are regarded by some authors as a distinct species, the black turtle, C. agassizii (King and Burke 1989); other authors (e.g., Ernst and Barbour 1989) retain agassizii as a subspecies of C. mydas (Kamezaki and Matsui 1995) or do not recognize it taxonomically at all (Crother et al. 2000). Phylogenetic analyses of mtDNA data by Bowen et al. (1992) yielded no evidence of matrilineal distinctiveness of agassizii. See Karl and Bowen (1999), Pritchard (1999), Grady and Quattro (1999), Shrader-Frechette and McCoy (1999), and Bowen and Karl (1999) for further debate about the taxonomic status of the black turtle. The Australian flatback turtle, formerly known as Chelonia depressa, has been removed to its own genus, Natator (Zangerl et al. 1988, Limpus et al. 1988). MtDNA data indicate a fundamental phylogenetic split distinguishing all green turtles in the Atlantic-Mediterranean from those in the Indian-Pacific oceans (Bowen et al. 1992). Most regional populations of Chelonia mydas are genetically distinct (Bowen et al. 1992). Florida population is characterized by unusually high mtDNA diversity (Allard et al. 1994) (NatureServe, 2015).

Historical Range

The present distribution of the breeding sites has been largely affected by historical patterns of human exploitation. Most of the substantial breeding colonies left today are those that have not been permanently inhabited by humans or have not been heavily exploited until recently (Groombridge and Luxmoore 1989, Seminoff 2004) (NMFS and USFWS, 2007).

Current Range

The range of the DPS extends from the boundary of South and Central America, north along the coast to include Panama, Costa Rica, Nicaragua, Honduras, Belize, Mexico, and the United States. It extends due east across the Atlantic Ocean at 48° N. and follows the coast south to include the northern portion of the Islamic Republic of Mauritania (Mauritania) on the African continent to 19° N. It extends west at 19° N. to the Caribbean basin to 65.1° W., then due south to 14° N., 65.1° W., then due west to 14° N., 77° W., and due south to 7.5° N., 77° W., the boundary of South and Central America. It includes Puerto Rico, the Bahamas, Cuba, Turks and Caicos Islands, Republic of Haiti, Dominican Republic, Cayman Islands, and Jamaica. The North

Atlantic DPS includes the Florida breeding population, which was originally listed as endangered under the ESA (43 FR 32800, July 28, 1978) (USFWS, 2016). he green sea turtle is globally distributed and commonly inhabits nearshore and inshore waters. The North Atlantic DPS green turtle is found in the north Atlantic Ocean and Gulf of Mexico (NMFS Chlorpyrifos, Diazinon, and Malathion BiOp, 2017). The green turtle has a circumglobal distribution, occurring throughout nearshore tropical, subtropical and, to a lesser extent, temperate waters. Green turtles from the North Atlantic DPS range from the boundary of South and Central America (7.5°N, 77°W) in the south, throughout the Caribbean, the Gulf of Mexico, and the U.S. Atlantic coast to New Brunswick, Canada (48°N, 77°W) in the north. The range of the DPS then extends due east along latitudes 48°N and 19°N to the western coasts of Europe and Africa. Nesting occurs primarily in Costa Rica, Mexico, Florida and Cuba (NMFS Chlorpyrifos, Diazinon, and Malathion BiOp, 2017).

Distinct Population Segments Defined

Yes

Critical Habitat Designated

No;

Life History

Feeding Narrative

Adult: Diet includes "seagrass," macroalgae and other marine vegetation, and various invertebrates such as mollusks, sponges, crustaceans, and jellyfish. Food Habits: Invertivore (Adult, Immature), Herbivore (Adult, Immature) Turtles in the northern Gulf of California overwinter in a dormant condition. Nesting occurs generally at night. In Hawaii, green sea turtles may bask on beaches mid-morning to mid-afternoon, especially after a period of rainy weather (Whittow and Balazs 1982) (NatureServe, 2015). Feeding occurs in shallow, low-energy waters with abundant submerged vegetation, and also in convergence zones in the open ocean (NMFS and USFWS 2007). Migrations may traverse open seas. Adults are tropical in distribution, whereas juveniles range into temperate waters (e.g., see Morreale and Standora, no date). Hatchlings often float in masses of marine macroalgae (e.g., Sargassum) in convergence zones. Coral reefs and rocky outcrops near feeding pastures often are used as resting areas. Inactive individuals may rest on the bottom in winter in the northern Gulf of California. Basking on beaches occurs in some areas (e.g., Hawaii). Nesting occurs on beaches, usually on islands but also on the mainland. Sand may be coarse to fine, has little organic content; physical characteristics vary greatly in different regions. Most nesting occurs on high energy beaches with deep sand. At least in some regions, individuals generally nest at same beach (apparently the natal beach, Meylan et al. 1990, Allard et al. 1994) in successive nestings, though individuals sometimes change to a different nesting beach within a single nesting season (has switched to beach up to several hundred kilometers away) (see Eckert et al. 1989). Beach development and illumination often make beaches unsuitable for successful nesting (NatureServe, 2015).

Reproduction Narrative

Adult: Individual reproductive females lay 1-8 clutches per season, averaging about 90-140 eggs, at about two-week intervals usually every 2-5 years. Nesting occurs March-October in Caribbean-Gulf of Mexico region, with peak in May-June; nests in Florida May-September (Ehrhart and Witherington 1992). Nesting encompasses April-October, with a peak between mid-June and early August, in Hawaii (Niethammer et al. 1997). Eggs hatch usually in 1.5-3 months. Hatchlings emerged between early July and late December (peak mid-August to early October) in Hawaii (Niethammer et al. 1997). Females mature probably at an average age of 27 years in Florida, but growth rates and hence age of maturity may vary greatly (from perhaps fewer than 20 years to 40+ years) throughout the range (slower growth in Australia, Hawaii, and Galapagos than in Florida and West Indies region).; Eggs and hatchlings typically incur high mortality from various terrestrial and aquatic predators, including both vertebrates and invertebrates (e.g., crabs). Many nests are destroyed by tidal inundation and erosion. In Costa Rica, annual survivorship of adult females was 0.61; in various areas egg survivorship was 0.40-0.86 (see Iverson [1991] for a compilation of survivorship data). Humans are the most important predators on adults. See Witherington and Ehrhart (1989) for information on cold stunning in Florida (NatureServe, 2015). Age at first reproduction for females is twenty to forty years. Green sea turtles lay an average of three nests per season with an average of one hundred eggs per nest. The remigration interval (i.e., return to natal beaches) is two to five years. Nesting occurs primarily on beaches with intact dune structure, native vegetation and appropriate incubation temperatures during summer months. After emerging from the nest, hatchlings swim to offshore areas and go through a post-hatchling pelagic stage where they are believed to live for several years. During this life stage, green sea turtles feed close to the surface on a variety of marine algae and other life associated with drift lines and debris. Adult turtles exhibit site fidelity and migrate hundreds to thousands of kilometers from nesting beaches to foraging areas. Green sea turtles spend the majority of their lives in coastal foraging grounds, which include open coastlines and protected bays and lagoons. Adult green turtles feed primarily on seagrasses and algae, although they also eat jellyfish, sponges and other invertebrate prey (NMFS Chlorpyrifos, Diazinon, and Malathion BiOp, 2017).

Site Fidelity

Adult: High (NMFS, 1991)

Habitat Narrative

Adult: Feeding occurs in shallow, low-energy waters with abundant submerged vegetation, and also in convergence zones in the open ocean (NMFS and USFWS 2007). Migrations may traverse open seas. Adults are tropical in distribution, whereas juveniles range into temperate waters (e.g., see Morreale and Standora, no date). Hatchlings often float in masses of marine macroalgae (e.g., Sargassum) in convergence zones. Coral reefs and rocky outcrops near feeding pastures often are used as resting areas. Inactive individuals may rest on the bottom in winter in the northern Gulf of California. Basking on beaches occurs in some areas (e.g., Hawaii). Nesting occurs on beaches, usually on islands but also on the mainland. Sand may be coarse to fine, has little organic content; physical characteristics vary greatly in different regions. Most nesting occurs on high energy beaches with deep sand. At least in some regions, individuals generally nest at same beach (apparently the natal beach, Meylan et al. 1990, Allard et al. 1994) in successive nestings, though individuals sometimes change to a different nesting beach within a single nesting season (has switched to beach up to several hundred kilometers away) (see Eckert et al. 1989). Beach development and illumination often make beaches unsuitable for successful nesting (NatureServe, 2015). It is generally accepted that green sea turtles return to their natal beaches. Green sea turtles do exhibit strong site fidelity in successive nesting seasons (NMFS, 1991)

Dispersal/Migration

Motility/Mobility

Adult: High (NatureServe, 2015)

Migratory vs Non-migratory vs Seasonal Movements

Adult: Migratory (NatureServe, 2015)

Dispersal

Adult: High (NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Adults migrate up to about 3,000 km between nesting beaches and feeding areas (e.g., between Ascension Island and the South American coast). See Balazs (1982) for a map of documented migrations between the major nesting area in Hawaii (French Frigate Shoals) and foraging areas elsewhere in the Hawaiian Islands. See Morreale and Standora (no date) for information on movements along the east coast of the United States. Seminoff et al. (2002) documented migration between nesting area on the coast of Michoacan (Mexico; January 2000) and a feeding ground on the Sonoran coast of the Gulf of California (Mexico; September 2000). See Mortimer and Porter (1989) for information on inter-nesting movements at Ascension Island. Neonates migrate far from natal beaches to foraging areas and return to natal beach to breed/nest up to 40+ years later (NatureServe, 2015).

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Number of Populations:

81 to >300 (NatureServe, 2015)

Population Size:

100,000 to >1,000,000 individuals (NatureServe, 2015)

Resistance to Disease:

Moderate (USFWS, 1991)

Population Narrative:

Number of subpopulations and especially population size undoubtedly have undergone a major decline over the long term. Decline of 30-70% At 46 nesting areas worldwide, representing most but not all of the global population, the latest data indicate that approximately 109,000-151,000 females nest each year (NMFS and USFWS 2007). Assuming an average remigration interval of 3 years, this indicates an adult female population size of roughly 327,000-453,000. Assuming an equal number of adult males yields 654,000-906,000 adults for this subset of the global population. This species is represented by a large number of nesting occurrences (more than 150 major and minor nesting areas in more than 80 nations worldwide) (NatureServe, 2015). High resiliency, redundancy and representation are based on the overall number of individuals in the DPS and the geographic range that the species inhabits. Fibropapillomas are common on immature green sea turtles in the Indian River population (USFWS, 1991). Historically, green turtles in the North Atlantic DPS were hunted for food, which was the principle cause of the population's decline. Apparent increases in nester abundance for the North Atlantic DPS in recent years are encouraging but must be viewed cautiously, as the datasets represent a fraction of a green sea turtle generation, up to fifty years. While the threats of pollution, habitat loss through coastal development, beachfront lighting, and fisheries bycatch continue, the North Atlantic DPS appears to be somewhat resilient to future perturbations (NMFS Chlorpyrifos, Diazinon, and Malathion BiOp, 2017). The Florida Index Nesting Beach Survey (INBS) records sea turtle nest counts on a standardized set of index beaches. Nest counts of green turtles set record highs in 2011, 2013, 2015, 2017 and 2019. In 2021, green turtle nest counts on the 27 core index beaches reached more than 24,000 nests recorded (NMFS Chlorpyrifos, Diazinon, and Malathion revised BiOp, 2022). Abundance: Worldwide, nesting data at 464 sites indicate that 563,826 to 564,464 females nest each year (Seminoff et al. 2015). Compared to other DPSs, the North Atlantic DPS exhibits the highest nester abundance, with approximately 167,424 females at 73 nesting sites, and available data indicate an increasing trend in nesting. The largest nesting site in the North Atlantic DPS is in Tortuguero, Costa Rica, which hosts 79% of nesting females for the DPS (Seminoff et al. 2015). Productivity / Population Growth Rate: For the North Atlantic DPS, the available data indicate an increasing trend in nesting. There are no reliable estimates of population growth rate for the DPS as a whole, but estimates have been developed at a localized level. Modeling by Chaloupka et al. (2008) using data sets of twenty-five years or more show the Florida nesting stock at the Archie Carr National Wildlife Refuge growing at an annual rate of 13.9%, and the Tortuguero, Costa Rica, population growing at 4.9%. Genetic Diversity: The North Atlantic DPS has a globally unique haplotype, which was a factor in defining the discreteness of the population for the DPS. Evidence from mitochondrial DNA studies indicates that there are at least four independent nesting subpopulations in Florida, Cuba, Mexico and Costa Rica (Seminoff et al. 2015). More recent genetic analysis indicates that designating a new western Gulf of Mexico management unit might be appropriate (Shamblin et al. 2016) (NMFS Chlorpyrifos, Diazinon, and Malathion BiOp, 2017).

Threats and Stressors

Stressor: Beach erosion (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of habitat/Loss of nests
Narrative: Erosion of nesting beaches can result in partial or total loss of suitable nesting habitat. Erosion rates are influenced by dynamic coastal processes, including sea level rise. Man's interference with these natural processes through coastal development and associated activities has resulted in accelerated erosion rates and interruption of natural shoreline migration (USFWS, 1991).

Stressor: Beach armoring (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Where beachfront development occurs, the site is often fortified to protect the property om erosion. Virtually all shoreline engineering is carried out to save structures, not dry sandy beaches, and ultimately results in environmental damage (USFWS, 1991).

Stressor: Beach nourishment (USFWS, 1991)

Exposure:
Response:
Consequence: Loss of habitat
Narrative: Beach nourishment consists of pumping, trucking, or scraping sand onto the beach to rebuild what has been lost to erosion. Beach nourishment can impact turtles through direct burial of nests and by disturbance to nesting turtles if conducted during the nesting season. Sand sources may be dissimilar from native beach sediments and can affect nest site selection, digging behavior, incubation temperature (and hence sex ratios), gas exchange parameters within incubating nests, hydric environment of the nest, hatching success and hatchling emergence success (Mann, 1977; Ackerman, 1980; Mortimer, 1982b; Raymond, 1984a). Beach nourishment can result in severe compaction or concretion of the beach. Trucking of sand onto project beaches may increase the level of compaction (USFWS, 1991).

Stressor: Artificial lighting (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of habitat/misorientation
Narrative: Extensive research has demonstrated that the principal component of the sea-finding behavior of emergent hatchlings is a visual response to light (Daniel and Smith, 1947; Hendrichon, 1958; Carr and Ogren, 1960; Ehrenfeld and Carr, 1967; Dickerson and Nelson, 1989; Witherington, 1989). Artificial beachfront lighting from buildings, streetlights, dune crossovers, vehicles and other types of beachfront lights have been documented in the disorientation (loss of bearings) and misorientation (incorrect bearing) of hatchling turtles (McFarlane, 1963; Philibosian, 1976; Mann, 1977; 1980; Ehrhart, 1983). The results of misorientation are often fatal. As hatchlings head toward lights or meander along the beach their exposure to predators and likelihood of desiccation is greatly increased. Misoriented hatchlings can become entrapped in vegetation or debris, and many hatchlings are found dead on nearby roadways and in parking lots after being struck by vehicles. Hatchlings that successfully find the water may be misoriented after entering the surf zone or while in nearshore waters. Intense artificial lighting can even md raw hatchlings back out of the surf (Daniel and Smith, 1947; Carr and Ogren, 1960). During 1988 alone, 10,155 misoriented hatchlings were reported to the FDNR. An unquantifiable number of additional disorientation and misorientation events undoubtedly occurred but were not documented due to depredation, entrapment in thick vegetation, loss in storm drains, or obliteration of carcasses by vehicle tires. The problem of artificial beachfront lighting is not restricted to hatchlings. Carr et al (15)78), Mortimer [1982b), and Witherington (1986) found that adult green turtles avoided bright areas on nesting beaches. Problem lights may not be restricted to those placed directly on or in close proximity to nesting beaches. %e background glow associated with intensive inland lighting, such as that emanating from nearby large metropolitan areas, may deter nesting females and misorient hatchlings navigating the nearshore haters. Cumulatively, along the heavily developed beaches of the southeastern United States, the negative effects of artificial lights are profound (USFWS, 1991).

Stressor: Beach cleaning (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of habitat/loss of nests
Narrative: Beach cleaning refers to the removal of both abiotic and biotic debris from developed beaches. There are several methods employed including mechanical raking, hand raking and

hand picking up of debris. Mechanical raking can result in heavy machinery repeatedly traversing nests and potentially compacting sand above nests and also results in tire ruts along the beach which may hinder or trap emergent hatchlings. Mann (1977) suggested that mortality within nests may increase when externally applied pressure from beach cleaning machinery is common on soft beaches with large grain sands. Mechanically pulled rakes and hand rakes can penetrate the surface and disturb the sealed nest or may actually uncover pre-emergent hatchlings near the surface of the nest. In some areas collected debris is buried directly on the beach, and this can lead to excavation and destruction of incubating egg clutches. Disposal of debris near the dune line or on the high beach can cover incubating egg clutches and subsequently hinder and entrap emergent hatchlings and may alter natural nest temperatures. In some areas, mechanical beach cleaning is the sole reason for extensive nest relocation (USFWS, 1991).

Stressor: Increased human presence (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of habitat/loss of nests/misorientation
Narrative: Residential and tourist use of developed (and developing) nesting beaches can result in negative impacts to nesting turtles, incubating egg clutches, and hatchlings. The most serious threat caused by increased human presence on the beach is the disturbance to nesting females. Night-time human activity can cause nesting females to abort nesting attempts at all stages of the behavioral process. Murphy (1985) reported that disturbance can cause turtles to shift their nesting beaches, delay egg laying and select poor nesting sites. Heavy utilization of nesting beaches by humans (pedestrian traffic) may result in lowered hatchling emergence success rates due to compaction of sand above nest (Mann, 1977), and pedestrian tracks can interfere with the ability of hatchlings to reach the ocean (Hosier et al., 198 1). Campfires and the use of flashlights on nesting beaches misorient hatchlings and can deter nesting females (Mortimer, 1979) (USFWS, 1991).

Stressor: Recreational beach equipment (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals/loss of nests
Narrative: The placement of physical obstacles (e.g., lounge chairs, cabanas, umbrellas, hobie cats, canoes, small boats, beach cycles) on nesting beaches can hamper or deter nesting attempts and interfere with incubating egg clutches and the sea approach of hatchlings. The documentation of false crawls at these obstacles is becoming increasingly common as more recreational beach equipment is left in place nightly on nesting beaches. Additionally, there are documented reports of nesting females becoming entrapped under heavy wooden lounge chairs and cabanas on south Florida nesting beaches (J. Hoover, pers. comm., S. Bass, pers. comm). The placement of recreational beach equipment directly above incubating egg clutches may hamper hatchlings during emergence and can destroy eggs through direct invasion of the nest (C. LeBuff, pers. comm.) (USFWS, 1991).

Stressor: Beach vehicular driving (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of nests/loss of individuals

Narrative: The operation of motor vehicles on nesting beaches for recreational purposes is permitted in northeast Florida (portions of Nassau, Duval, St. John's, Flagler and Volusia counties), northwest Florida (Walton and Gulf Counties), and North Carolina (Emerald Isle, Cape Lookout National Seashore, Cape Hatteras National Seashore and Currituck Banks). While some areas restrict night driving, others permit it. Driving on beaches at night during the nesting season can disrupt the nesting process and result in aborted nesting attempts. The negative impact on nesting females in the surf zone may be particularly severe. Vehicle headlights can disorient or misorient emergent hatchlings and vehicles can strike and kill hatchlings attempting to reach the ocean. The tracks or ruts left by vehicles traversing the beach interfere with the ability of hatchlings to reach the ocean. The extended period of travel required to negotiate tire tracks and ruts may increase the susceptibility of hatchlings to stress and depredation during transit to the ocean (Hosier et d., 1981; M. Evans, FDNR, pers. comm.). Driving directly above incubating egg clutches can cause sand compaction which may decrease nest success and directly kill pre-emergent hatchlings (Mann, 1977). In many areas, beach vehicular driving is the sole cause for nest relocation. Additionally, vehicle traffic on nesting beaches contributes to erosion, especially during high tides or on narrow beaches where driving is concentrated on the high beach and foredune (USFWS, 1991).

Stressor: Exotic dune and beach vegetation (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Non-native vegetation has invaded many coastal areas and often outcompetes native species such as sea oats, railroad vine, sea grape, dune panic grass and pennywort. The invasion of less stabilizing vegetation can lead to increased erosion and degradation of suitable nesting habitat. Exotic vegetation may also form impenetrable root mats which can prevent proper nest cavity excavation, invade and desiccate eggs or trap hatchlings (USFWS, 1991).

Stressor: Nest depredation (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of nests
Narrative: A variety of natural and introduced predators such as raccoons, feral hogs, foxes, ghost crabs and ants prey on incubating eggs and hatchling sea turtles. The principal predator is the raccoon (Procyon lotor). Raccoons are particularly destructive and may take up to 96 percent of all nests deposited on a beach (Davis and Whiting, 1977; Hopkins and Murphy, 1980; Stancyk et al., 1980; Talbert et al., 1980; Schroeder, 1981; Labisky et al., 1986). Prior to hog control efforts, up to 45 percent of all sea turtle nests deposited at the Cape Canaveral Air Force Station, Florida, were depredated by feral hogs (FDNR, unpubl. data). In addition to the destruction of eggs, certain predators may take considerable numbers of hatchlings just prior to or upon emergence from the sand (USFWS, 1991).

Stressor: Nest Loss and Abiotic Factors (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of nests
Narrative: Nest loss due to erosion or inundation and accretion of sand above incubating nests appear to be the principal abiotic factors which may negatively affect incubating: egg clutches.

while these factors are often widely perceived as contributing significantly to nest mentality or lowering hatching success, few quantitative studies have been conducted (Mortimer, 1989). Studies on a relatively undisturbed nesting beach by Witherington (1986) indicated that excepting a late season severe storm event, erosion and inundation played a relatively minor role in destruction of incubating nests. Inundation of nests and accretion of sand above incubating nests as a result of a late season storm played a major role in destroying nests from which hatchlings had not yet emerged. Severe storm events (e.g., tropical storms, hurricanes) may result in significant nest loss, but these events are typically aperiodic rather than annual occurrences. In the southeastern United States, severe storm events are generally experienced after the peak of the hatching season and hence would not be expected to affect the majority of incubating nests. Erosion and inundation of nests is exacerbated through coastal development and shoreline engineering. These threats are discussed above under beach armoring (USFWS, 1991).

Stressor: Poaching (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: In the United States, take of nesting female green turtles is infrequent. However, in a number of areas, egg poaching and clandestine markets for eggs are not uncommon. During the period 1983 - 1989 the Florida Marine Patrol made 29 arrests for illegal possession of turtle eggs (figure: not apportioned by species) (USFWS, 1991). Illegal directed harvesting of juvenile and adult green turtles in the waters of the continental United States and U.S. Caribbean is not uncommon, but no estimates of the level of take exist. During the period 1983-1989, the Florida Marine Patrol made three arrests for illegal possession of whole turtles and 25 arrests for illegal possession of turtle parts within Florida (figures are not apportioned by species). Illegal take of green turtles in the United States Caribbean, particularly in Puerto Rican waters, is likely the most significant problem (USFWS, 1991).

Stressor: Oil and gas exploration, development and transportation (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Experimental and field results reported by Vargo pt al. (1986) indicate that marine turtles would be at substantial risk if they encountered an oil spill or large amounts of tar in the environment. Physiological experiments indicate that the respiration, skin, some aspects of blood chemistry and composition, and salt gland function of marine turtles are significantly affected (Vargo et al., 1986). Spills in the vicinity of nesting beaches are of special concern and could place nesting adults, incubating egg clutches (Fritts and McGehee, 1989) and hatchlings at significand risk. Exploration and oil development on live bottom areas may disrupt foraging grounds by smothering benthic organisms with sediments and drilling muds (Coston-Clements and Hoss, 1983). Oil and tar are also released into the marine environment during pumping of bilges on large vessels. In a review of available information on debris ingestion, Balazs (1985) reported that tar balls were the second most prevalent type of abiotic debris ingested by marine turtles (USFWS, 1991).

Stressor: Dredging (USFWS, 1991)
Exposure:

Response:
Consequence: Loss of habitat/loss of individuals
Narrative: The effects of dredging are evidenced through direct destruction or degradation of habitat and incidental take of marine turtles. Channelization of inshore and nearshore habitat and the disposal of dredged material in the marine environment can destroy or disrupt resting or foraging grounds (including grass beds and coral reefs) and may affect nesting distribution through the alteration of physical features in the marine environment (Hopkins and Murphy, 1980). Hopper dredges are responsible for incidental take and mortality of marine turtles during dredging operations. During a 3-month period in 1980 in the Port Canaveral, Florida, channel, dredging operations were responsible for the mortality of approximately 100 turtles. These high levels of incidental take have not been documented during dredging operations in subsequent years. Maintenance dredging of the Kings Bay, Georgia, channel during 1987-1988 resulted in the mortality of approximately 20 turtles during a 1 year period. Other types of dredges (clamshell and pipeline) have not been implicated in incidental take (USFWS, 1991).

Stressor: Marina and dock development (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: The development of marinas and private or commercial docks in inshore waters can negatively impact turtles through destruction or degradation of foraging habitat. Additionally, this type of development leads to increased boat and vessel traffic which may result in higher incidences of propeller- and collision-related mortality. Fueling facilities at marinas can result, in the discharge of oil and gas into sensitive estuarine habitat (USFWS, 1991).

Stressor: Pollution (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of habitat/decreased nesting success
Narrative: The effects of pollutants resulting from industrial, agricultural or residential sources are difficult to evaluate. Pesticides, heavy metals and PCB's have been detected in turtles (including eggs), but levels which result in adverse effects have not been quantified (Nelson, 1988) (USFWS, 1991).

Stressor: Seagrass bed degradation (USFWFS, 1991)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Boating activities in areas of seagrass beds can result in damage through anchoring and propeller scarring. In the United States Virgin Islands, seagrasses recovered only minimally in areas damaged by anchoring even after a period of seven months (Williams, 1988), and a decline in seagrass distribution was documented over a 30-year period in selected bays. The loss of available foraging habitat resulted in a lowered carrying capacity for specific bays (Williams, 1988). Extensive die-offs of seagrass beds in Florida Bay have recently been reported, and this may have serious consequences for the green turtles which forage there. The cause(s) of that decline have not yet been identified (USFWS, 1991).

Stressor: Trawl fisheries (USFWS, 1991)

Exposure:
Response:
Consequence: Loss of individuals
Narrative: Of all commercial and recreational fisheries conducted in the United States, shrimp trawling is the most damaging to the recovery of marine turtles. The estimated number of green turtles captured annually is approximately 925 of which approximately 225 die (T. Henwood, pers. comm.). Incidental capture and drowning in shrimp trawls is believed to be the largest single source of mortality on juvenile through adult stage marine turtles in the southeastern United States. The majority of these turtles are juveniles and subadults, the age/size classes most critical to the stability and recovery of marine turtle populations (Crouse et al., 1987). Quantitative estimates of turtle take by shrimp trawlers in inshore waters have not been developed, but the level of trawling effort expended in inshore waters along with increasing documentation of the utilization of inshore habitat by green turtles suggest that capture and mortality may be significant. Trawlers targeting species other than shrimp tend to use larger nets than shrimp trawlers and probably also take sea turtles, although capture levels have not been developed. These fisheries include, but are not limited to, bluefish, croaker, flounder, calico scallops, blue crab, and whelk. Of these, the bluefish, croaker, and flounder trawl fisheries likely pose the most serious threat (T. Henwood, pers. comm) (USFWS, 1991).

Stressor: Purse seine fisheries (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Several purse seine fisheries operate in Gulf of Mexico and Atlantic, including those targeting menhaden and sardines. Turtles may be taken in these fisheries, but the level of take and percent mortality is currently unquantified (USFWS, 1991).

Stressor: Hook and line fisheries (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Several thousand commercial vessels are engaged in hook and line fisheries which target various species including coastal species, reef fish, and pelagic species. In addition to commercial take, the recreational fishery is extensive. Turtle captures on hook and line gear are not uncommon, but the level of take and percent mortality are unknown. It is assumed that most turtles are released alive, although ingested hooks and entanglement in associated monofilament/steel line have been documented as the probable cause of death in some stranded turtles (USFWS, 1991).

Stressor: Gill net fisheries (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Gill nets are utilized both in inshore and offshore areas for various species and may be stationary or drifting. Mesh size is dependent on the size of the fish which are targeted but the gear is considered non-selective in the species impacted (T. Henwood, pers. comm.). Trammel nets are modified gill nets set in panels of webbing of variable mesh size. Marine turtles are vulnerable to entanglement and drowning in gill and trammel nets, especially when this gear is

left unattended. turtle mortalities resulting from the use of gill nets set for sturgeon in South Carolina and North Carolina have been documented (Ulrich, 1978; Crouse, 1982). In response to this documented take, the state of South Carolina has prohibited gill netting for sturgeon since 1986. Of particular concern are the gill net and trammel net fisheries off the Florida east-central coast. These fisheries, primarily targeting king mackerel, pompano, and shark have undergone recent expansion in the number of vessels and level of fishing effort (Schaefer et d., 1987). Stranding patterns of turtles in this area indicate that significant numbers of turtles may be killed incidental to these fisheries. This may be particularly detrimental to the juvenile green turtle population(s) inhabiting this coastal area. (USFWS, 1991).

Stressor: Pound net fisheries (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: York, and Rhode Island. In Virginia, pound nets have been identified as a leading cause of marine turtle mortality (Lutcavage and Musick, 1985). Mortality was principally caused by entanglement and drowning in the leader portion of the gear and was dependent on mesh size., net location, and environmental parameters. In North Carolina, most pound nets have leads constructed of small mesh (5-8"). Results of preliminary investigations indicate that mortality in these nets may be infrequent (Epperly and Veishlow, 1989). Similarly, in New York, most turtles are released alive from pound nets and entanglement in leaders appears infrequent (V. Burke, pers. comm.) (USFWS, 1991).

Stressor: Longline fisheries (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Longline fisheries have increased dramatically over the past several years. Species targeted in these fisheries include tuna, shark, and swordfish. Witzell (1987) estimated that 330 turtles were incidentally captured in the Gulf of Mexico and Atlantic by the Japanese tuna longline fleet during 1978-1981. Due to increased effort and expansion of longline fisheries in recent years, it is believed that longline fisheries may be exerting a major negative impact on marine turtle recovery (T. Henwood, pers. comm.) (USFWS, 1991).

Stressor: Trap fisheries (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Traps are commonly used in the capture of crabs, lobster, and reef fish. Traps vary in size and configuration but all are attached to a surface float by means of a line leading to the trap. Turtles can become entangled in trap lines below the surface of the water and subsequently drown. In other instances, stranded turtles have been recovered entangled in trap line with the trap in tow. The impact of this gear on green turtle populations has not been quantified (USFWS, 1991).

Stressor: Boat collisions (USFWS, 1991)
Exposure:
Response:

Consequence: Loss of individuals
Narrative: Propeller and collision injuries to marine turtles from boats and ships are not uncommon. In 1986, 1987, and 1988, respectively 5.8 percent (1 1 I), 7.3 percent (175), and 9.0 percent (179) of all stranded turtles reported in the United States Gulf of Mexico and Atlantic were documented as having sustained some type of propeller or collision injuries, although it is unknown what percentage of these injuries were post-mortem versus ante-mortem (Schroeder and Warner, 1988; Teas and Martinez, 1989). These types of injuries are recorded at higher frequencies in areas where recreational boating and vessel traffic is intense, such as south Florida, the Florida Keys and United States Virgin Islands (USFWS, 1991).

Stressor: Power plant entrapment (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: The entrainment and entrapment of turtles in saltwater cooling intake systems of coastal power plants has been documented in New Jersey, North Carolina, Florida, and Texas (Roithmayr and Henwood, 1982; Ernest et d; 1989; S. Manzella, pers. comm; T. Henson, pers. comm.; R. Schoelkopf, pers. comm.). Average annual incidental capture rates for most coastal plants from which captures have been reported amount to several turtles per plant per year. One notable exception is the St. Lucie nuclear power plant located on Hutchinson Island, Florida. During a 13-year period of operation (March 1976 - December 1988), 1,929 turtles of all species have been removed from the intake canal. The mortality rate is approximately 7.0 percent (Applied Biology, Inc., unpubl. data). Most captures have been loggerheads, though green turtles are not uncommon. (USFWS, 1991).

Stressor: Underwater explosions (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: The use of underwater explosives for the removal of abandoned oil platforms, military activities, and oil exploration can injure or kill turtles and may destroy or degrade habitat. During a 3-year period (1986-1988) observers reported one injured (or dead) turtle during the removal of 103 offshore oil structures in the Gulf of Mexico. Of eight turtles deliberately exposed to underwater explosions at distances varying between 229 m and 915 m from the detonation site, five were rendered unconscious (Klima et al; 1989) (USFWS, 1991).

Stressor: Offshore artificial lighting (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of habitat/misorientation
Narrative: The effects of offshore lighted structures on the orientation of hatchling turtles is not completely understood. These lights may attract hatchlings and interfere with proper offshore orientation, and may make them more susceptible to predation (deSilva, 1982) (USFWS, 1991).

Stressor: Entanglement (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals

Narrative: Turtles are affected to an unknown but potentially significant degree by entanglement in persistent marine debris, including discarded or lost fishing gear (Balazs, 1985). Green turtles have been found entangled in a wide variety of materials including steel and monofilament line, synthetic and natural rope, plastic onion sacks and discarded plastic netting materials (Balazs, 1985; Plotkin and Amos, 1988). Monofilament line appears to be the principal source of entanglement for green turtles in U.S. waters. Records from Florida and the United States Virgin Islands indicate that some entanglement results from netting and monofilament line which has accumulated on both artificial and natural reefs. These areas are often heavily fished, resulting in snagging of hooks and discarding of lines. Turtles foraging and/or resting in these areas can become entangled and drown (FDNR, unpubl. data). 'The alignment of persistent marine debris along convergences, rips, and driftlines and the concentration of young sea turtles along these fronts increases the likelihood of entanglement at this life history stage (Carr, 1987) (USFWS, 1991).

Stressor: Ingestion of marine debris (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Marine turtles have been found to ingest a wide variety of abiotic debris items such as plastic bags, raw plastic pellets, plastic and styrofoam pieces, tar balls and balloons. Effects of debris ingestion can include direct obstruction of the gut, absorption of toxic byproducts and reduced absorption of nutrients across the gut wall (Balazs, 1985). Studies conducted by Lutz (in press) revealed that both loggerhead and green turtles actively ingested small pieces of latex and plastic sheeting. Physiological data indicated a possible interference in energy metabolism or gut function, even at low levels of ingestion. Persistence of the material in the gut lasted from a few days to 4 months (Lutz, in press). Of particular concern is the co-occurrence of persistent marine debris and the early life history pelagic stages of green turtles along convergences. Young turtles are dependent upon these driftlines for their food supply, and hence the likelihood of debris ingestion is increased (Carr, 1987). While quantitative data on population effects are undetermined, the impacts of debris ingestion are considered serious (USFWS, 1991).

Stressor: Disease and parasites (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: There is little information available to assess the comprehensive effects of disease and/or parasites on wild populations of green turtles. The vast majority of diseases and conditions which have been identified or diagnosed in sea turtles are described from captive stock, either turtles in experimental headstart programs or mariculture facilities (Wolke, 1989). One notable exception is the occurrence of fibropapillomas on green turtles, first described by Smith and Coates (1938). Fibropapillomas are now common on immature green turtles in the central Indian River system of Florida, Florida Bay, and in the Florida Keys (Ehrhart et al., 1986; Witherington and Ehrhart, 1987; Schroeder, 1987a). In the central Indian River lagoon, approximately half of all green turtles captured have been found to bear papillomas of varying degree (Ehrhart et al., 1986). Recent reports from Puerto Rico and the United States Virgin Islands indicate a very low occurrence of fibropapillomas on green turtles collected in these areas (R. Boulon and J. Collazo, pers. comm.). Fibropapillomas are also commonly found on Hawaiian green turtles. These tumor like growths can result in reduced vision, disorientation, blindness,

physical obstruction to normal swimming and feeding, an apparent increased susceptibility to parasitism by marine leeches, and an increased susceptibility to entanglement in monofilament fishing line (Balazs, 1986). Blood counts and serum profiles of green turtles inflicted with fibropapillomas indicate marked debilitation (Jacobson, 1987) (USFWS, 1991).

Stressor: Predation (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Predation of hatchling and very young turtles is assumed to be significant and predation of subadult through adult stage turtles is assumed less common, but valid estimates of mortality due to predation at various life history stages are extremely difficult, if not impossible, to obtain and have not been determined. Hatchlings entering the surf zone and pelagic stage hatchlings may be preyed upon by a wide variety of fish species and to a lesser extent, marine birds. Stancyk (1982) in an extensive literature review reported predators of juvenile and adult turtles to include at least six species of sharks, killer whales, bass, and grouper. Tiger sharks appear to be the principal predator of subadult and adult turtles. While stranded turtles may exhibit shark inflicted injuries, caution must be exercised in attributing a cause of death as these wounds can be inflicted post-mortem (USFWS, 1991).

Recovery

Delisting Criteria:
The United States population of green turtles can be considered for delisting if, over a period of 25 years, the following conditions are met: 1. The level of nesting in Florida has increased to an average of 5,000 nests per year for at least 6 years. Nesting data must be based on standardized surveys (USFWS, 1991).

2. At least 25 percent (105 km) of all available nesting beaches (420 km) is in public ownership and encompasses at least 50 percent of the nesting activity (USFWS, 1991).

3. A reduction in stage class mortality is reflected in higher counts of individuals on foraging grounds (USFWS, 1991).

4. All priority one tasks have been successfully implemented (USFWS, 1991).

Recovery Actions:

- 1. Protect and manage habitats. 11. Protect and manage nesting habitat. 111. Ensure beach nourishment projects are compatible with maintaining good quality nesting habitat. (also see 215). 1111. Implement and evaluate tilling as a means of softening compacted beaches. 1112. Evaluate the relationship of sand characteristics (including aragonite) and hatch success, hatchling sex ratios, and nesting behavior. 1113. Reestablish dunes and native vegetation. 1114. Evaluate sand transfer systems as alternative to beach nourishment. 112. Prevent degradation of nesting habitat from seawalls, revetments, sand bags, sand fences, or other erosion control measures. 1121. Evaluate current laws on beach armoring and strengthen if necessary. 1122. Ensure laws regulating coastal construction and beach armoring are enforced. 1123. Ensure failed erosion control structures are removed. 1124. Develop standard requirements for sand fence construction. 113. Acquire or otherwise ensure the long-term protection of key nesting beadles. 1131. Acquire in fee title all undeveloped nesting beaches between Melbourne Beach and Wabasso Beach, Florida. 1132. Evaluate the status of the important nesting beaches on Hutchinson Island, Florida, and develop a plan for long-term protection. 114. Remove exotic vegetation and prevent spread to nesting beaches. 12. Protect marine habitat. 121. Identify important habitat. 122. Prevent degradation and improve water quality of important turtle habitat. 123. Prevent destruction of habitat from fishing gears and vessel anchoring. 124. Prevent destruction of marine habitat from oil and gas activities. 125. Prevent destruction of habitat from dredging activities. 126. Restore important foraging habitats (USFWS, 1991).

- 2. Protect and manage population. 21. Protect and manage populations on nesting beaches. 211. Monitor trends in nesting activity by means of standardized surveys. 212. Evaluate nest success and implement appropriate nest protection measures. 213. Determine influence of factors such as tidal inundation and foot traffic on hatching success. 214. Reduce effects of artificial lighting on hatchlings and nesting females. 2141. Determine hatchling orientation mechanisms in the marine environment and assess dispersal patterns from natural (dark) beaches and beaches with high levels of artificial lighting. 2142. Implement and enforce lighting ordinances. 2143. Evaluate extent of hatchling disorientation on all important regional nesting beaches. 2144. Evaluate need for Federal lighting regulations. 2145. Develop lighting plans at Kennedy Space Center, Port Canaveral, Cape Canaveral Air Force Station and Patrick Air Force Base, Florida. 2146. Prosecute individuals or entities responsible for hatchling disorientation or misorientation under the Endangered Species Act or appropriate State laws. 215. Ensure beach nourishment and coastal construction activities are planned to avoid disruption of nesting and hatching activities. 216. Ensure law enforcement activities eliminate poaching and harassment. 217. Determine natural hatchling sex ratios. 22. Protect and manage populations in the marine environment. 221. Determine green turtle distribution, abundance and status in the marine environment. 2211. Determine seasonal distribution, abundance, population characteristics, and status in bays, sounds and other important nearshore habitats. 2212. Determine adult navigation mechanisms, migratory pathways, distribution and movements between nesting seasons. 2213. Determine present or potential threats to green turtles along migratory routes and on foraging grounds. 2214. Determine breeding population origins for U.S. juvenile/subadult populations. 2215. Determine growth rates, age of sexual maturity and survivorship rates of hatchlings, juveniles, and adults. 222. Monitor and reduce mortality from commercial and recreational fisheries. 2221. Implement and enforce TED regulations in all United States waters at all times. 2222. Provide technology transfer for installation and use of TEDs. 2223. Maintain the Sea Turtle Stranding and Salvage Network. 2224. Identify and monitor other fisheries that may be causing significant mortality. 2225. Promulgate regulations to reduce fishery related mortalities. 223. Monitor and reduce mortality from dredging activities. 2231. Monitor turtle mortality on dredges. 2232. Evaluate modifications of dredge dragheads or devices to reduce turtle captures, and incorporate effective modifications or devices into future dredging operations. 2233. Determine seasonality and abundance of sea turtles at dredging localities, and ensure that dredging is restricted to time periods with the least potential for turtle mortality. 224. Monitor and prevent adverse impacts from oil and gas activities. 2241. Determine the effects of oil and oil dispersants on all life stages. 2242. Ensure that impacts to sea turtles are adequately addressed during planning of oil and gas development. 2243. Determine sea turtle distribution and seasonal use of marine habitats associated with oil and gas development areas. 224. Reduce impacts from entanglement and ingestion of persistent marine debris. 2251. Evaluate the extent of entanglement and

ingestion of persistent marine debris. 2252. Evaluate the effects of ingestion of persistent marine debris on health and viability of sea turtles. 2253. Determine and implement appropriate measures to reduce or eliminate persistent marine debris in the marine environment. 226, Increase law enforcement efforts to reduce poaching in United States waters. 227, Determine etiology of fibropapillomatosis. 228. Centralize administration and coordination of tagging programs. 2281. Centralize tag series records. 2282. Centralize turtle tagging records. 229. Ensure proper care of sea turtles in captivity. 2291. Develop standards for care and maintenance including diet, water quality and tank size. 2292. Develop manual for treatment of disease and injuries. 2293. Establish catalog for all captive sea turtles to enhance utilization for research and education. 2294. Designate rehabilitation facilities (USFWS, 1991).
- 3. Information and education. 31. Provide slide programs and information leaflets on sea turtle conservation for general public. 32. Develop brochure on recommended lighting modifications or measures to reduce hatchling disorientation and misorientation. 34. Develop public service announcements regarding the sea turtle artificial lighting conflict, and disturbance of nesting activities by public nighttime beach activities. 34. Ensure facilities permitted to hold and display captive sea turtles have appropriate informational displays. 35. Post information signs at public access points on important nesting beaches (USFWS, 1991).
- 4. International cooperation. 41. Develop international agreements to ensure protection of life stages which occur in foreign waters (USFWS, 1991).

References

U.S. Fish and Wildlife Service. 2016. Endangered and Threatened Wildlife and Plants

Final Rule To List Eleven Distinct Population Segments of the Green Sea Turtle (Chelonia mydas) as Endangered or Threatened and Revision of Current Listings Under the Endangered Species Act. 81 FR 20057

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia.

USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/speciesProfile/. Accessed April 2016.

National Marine Fisheries Service. 2017. Biological Opinion on the Environmental Protection Agency's Registration of Pesticides containing Chlorpyrifos, Diazinon, and Malathion. Consultation Tracking number: FPR-2017-9241. Digital Object Identifier (DOI): https://doi.org/10.7289/V5CJ8BQM

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1991. Recovery Plan for the U.S. Population of Atlantic Green Turtle. National Marine Fisheries Service, Washington, D.C

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A."

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1991. Recovery Plan for the U.S. Population of Atlantic Green Turtle. National Marine Fisheries Service, Washington, D.C.

National Marine Fisheries Service. 2017. Biological Opinion on the Environmental Protection Agency's Registration of Pesticides containing Chlorpyrifos, Diazinon, and Malathion. Consultation Tracking number: FPR-2017-9241. Digital Object Identifier (DOI): https://doi.org/10.7289/V5CJ8BQM National Marine Fisheries Service. 2022. DRAFT Revised Conference and Biological Opinion on the Environmental Protection Agency's Registration Review of Pesticide Products containing Chlorpyrifos, Malathion, and Diazinon. Consultation Tracking Number: OPR-2019-04081

OPR-2019-04082

OPR-2019-04083.

SPECIES ACCOUNT: *Chelonia mydas* (Green sea turtle (S Atlantic DPS))

Species Taxonomic and Listing Information

Listing Status: Threatened; Southeast Region (R4) (USFWS, 2015) 7/28/1978

Physical Description

A sea turtle with a brown carapace, often with radiating mottled or wavy dark markings or large dark brown blotches; 4 costal plates on each side of carapace; first costal does not contact the nuchal; one pair of prefrontal plates between the eyes; limbs are flattened flippers; young are black to dark brown above, mainly white below, with a mid-dorsal keel and two plastral keels, 4-6 cm at hatching; adult carapace length usually 90-122 cm (to 153 cm), mass 113-204 kg (to 295+ kg) (Conant and Collins 1991). LENGTH:122 WEIGHT: 200000 (NatureServe, 2015). The green sea turtle is the largest of the hardshell marine turtles, growing to a weight of 350 pounds (159 kilograms) and a straight carapace length of greater than 3.3 feet (1 meter) (NMFS Chlorpyrifos, Diazinon, and Malathion BiOp, 2017).

Taxonomy

Eastern Pacific populations of Chelonia are regarded by some authors as a distinct species, the black turtle, C. agassizii (King and Burke 1989); other authors (e.g., Ernst and Barbour 1989) retain agassizii as a subspecies of C. mydas (Kamezaki and Matsui 1995) or do not recognize it taxonomically at all (Crother et al. 2000). Phylogenetic analyses of mtDNA data by Bowen et al. (1992) yielded no evidence of matrilineal distinctiveness of agassizii. See Karl and Bowen (1999), Pritchard (1999), Grady and Quattro (1999), Shrader-Frechette and McCoy (1999), and Bowen and Karl (1999) for further debate about the taxonomic status of the black turtle. The Australian flatback turtle, formerly known as Chelonia depressa, has been removed to its own genus, Natator (Zangerl et al. 1988, Limpus et al. 1988). MtDNA data indicate a fundamental phylogenetic split distinguishing all green turtles in the Atlantic-Mediterranean from those in the Indian-Pacific oceans (Bowen et al. 1992). Most regional populations of Chelonia mydas are genetically distinct (Bowen et al. 1992). Florida population is characterized by unusually high mtDNA diversity (Allard et al. 1994) (NatureServe, 2015).

Historical Range

The present distribution of the breeding sites has been largely affected by historical patterns of human exploitation. Most of the substantial breeding colonies left today are those that have not been permanently inhabited by humans or have not been heavily exploited until recently (Groombridge and Luxmoore 1989, Seminoff 2004) (NMFS and USFWS, 2007).

Current Range

The range of the South Atlantic DPS begins at the border of Panama and Colombia at 7.5° N., 77° W., heads due north to 14° N., 77° W., then east to 14° N., 65.1° W., then north to 19° N., 65.1° W., and along 19° N. latitude to Mauritania in Africa, to include the U.S. Virgin Islands in the Caribbean. It extends along the coast of Africa to South Africa, with the southern border being 40° S. latitude (NMFS, 2016). (NMFS Chlorpyrifos, Diazinon, and Malathion BiOp, 2017). The green turtle has a circumglobal distribution, occurring throughout nearshore tropical, subtropical and, to a lesser extent, temperate waters. Nesting for the green turtle South Atlantic DPS occurs on both sides of the Atlantic Ocean, along the western coast of Africa, Ascension Island, the U.S. Virgin Islands in the Caribbean and eastern South America, from Brazil north to the Caribbean. Juveniles and adults can be found on feeding grounds in the Caribbean and the nearshore waters of Brazil, Uruguay and Argentina. In the east, South Atlantic DPS green turtles can be found on foraging grounds off the coast of west Africa, from Equatorial Guinea, Gabon, Congo, Angola and Principe Island (NMFS Chlorpyrifos, Diazinon, and Malathion BiOp, 2017).

Distinct Population Segments Defined

Yes

Critical Habitat Designated

No;

Life History

Feeding Narrative

Adult: Diet includes "seagrass," macroalgae and other marine vegetation, and various invertebrates such as mollusks, sponges, crustaceans, and jellyfish. Food Habits: Invertivore (Adult, Immature), Herbivore (Adult, Immature) Turtles in the northern Gulf of California overwinter in a dormant condition. Nesting occurs generally at night. In Hawaii, green sea turtles may bask on beaches mid-morning to mid-afternoon, especially after a period of rainy weather (Whittow and Balazs 1982) (NatureServe, 2015). Feeding occurs in shallow, low-energy waters with abundant submerged vegetation, and also in convergence zones in the open ocean (NMFS and USFWS 2007). Migrations may traverse open seas. Adults are tropical in distribution, whereas juveniles range into temperate waters (e.g., see Morreale and Standora, no date). Hatchlings often float in masses of marine macroalgae (e.g., Sargassum) in convergence zones. Coral reefs and rocky outcrops near feeding pastures often are used as resting areas. Inactive individuals may rest on the bottom in winter in the northern Gulf of California. Basking on beaches occurs in some areas (e.g., Hawaii). Nesting occurs on beaches, usually on islands but also on the mainland. Sand may be coarse to fine, has little organic content; physical characteristics vary greatly in different regions. Most nesting occurs on high energy beaches with deep sand. At least in some regions, individuals generally nest at same beach (apparently the natal beach, Meylan et al. 1990, Allard et al. 1994) in successive nestings, though individuals sometimes change to a different nesting beach within a single nesting season (has switched to beach up to several hundred kilometers away) (see Eckert et al. 1989). Beach development and illumination often make beaches unsuitable for successful nesting (NatureServe, 2015).

Reproduction Narrative

Adult: Individual reproductive females lay 1-8 clutches per season, averaging about 90-140 eggs, at about two-week intervals usually every 2-5 years. Nesting occurs March-October in Caribbean-Gulf of Mexico region, with peak in May-June; nests in Florida May-September (Ehrhart and Witherington 1992). Nesting encompasses April-October, with a peak between mid-June and early August, in Hawaii (Niethammer et al. 1997). Eggs hatch usually in 1.5-3 months. Hatchlings emerged between early July and late December (peak mid-August to early October) in Hawaii (Niethammer et al. 1997). Females mature probably at an average age of 27 years in Florida, but growth rates and hence age of maturity may vary greatly (from perhaps fewer than 20 years to 40+ years) throughout the range (slower growth in Australia, Hawaii, and Galapagos than in Florida and West Indies region).; Eggs and hatchlings typically incur high mortality from various terrestrial and aquatic predators, including both vertebrates and invertebrates (e.g., crabs). Many nests are destroyed by tidal inundation and erosion. In Costa

Rica, annual survivorship of adult females was 0.61; in various areas egg survivorship was 0.40-0.86 (see Iverson [1991] for a compilation of survivorship data). Humans are the most important predators on adults. See Witherington and Ehrhart (1989) for information on cold stunning in Florida (NatureServe, 2015). Age at first reproduction for females is twenty to forty years. Green sea turtles lay an average of three nests per season with an average of one hundred eggs per nest. The remigration interval (i.e., return to natal beaches) is two to five years. Nesting occurs primarily on beaches with intact dune structure, native vegetation and appropriate incubation temperatures during summer months. After emerging from the nest, hatchlings swim to offshore areas and go through a post-hatchling pelagic stage where they are believed to live for several years. During this life stage, green sea turtles feed close to the surface on a variety of marine algae and other life associated with drift lines and debris. Adult turtles exhibit site fidelity and migrate hundreds to thousands of kilometers from nesting beaches to foraging areas. Green sea turtles spend the majority of their lives in coastal foraging grounds, which include open coastlines and protected bays and lagoons. Adult green turtles feed primarily on seagrasses and algae, although they also eat jellyfish, sponges and other invertebrate prey (NMFS Chlorpyrifos, Diazinon, and Malathion BiOp, 2017).

Site Fidelity

Adult: High (NMFS, 1991)

Habitat Narrative

Adult: Feeding occurs in shallow, low-energy waters with abundant submerged vegetation, and also in convergence zones in the open ocean (NMFS and USFWS 2007). Migrations may traverse open seas. Adults are tropical in distribution, whereas juveniles range into temperate waters (e.g., see Morreale and Standora, no date). Hatchlings often float in masses of marine macroalgae (e.g., Sargassum) in convergence zones. Coral reefs and rocky outcrops near feeding pastures often are used as resting areas. Inactive individuals may rest on the bottom in winter in the northern Gulf of California. Basking on beaches occurs in some areas (e.g., Hawaii). Nesting occurs on beaches, usually on islands but also on the mainland. Sand may be coarse to fine, has little organic content; physical characteristics vary greatly in different regions. Most nesting occurs on high energy beaches with deep sand. At least in some regions, individuals generally nest at same beach (apparently the natal beach, Meylan et al. 1990, Allard et al. 1994) in successive nestings, though individuals sometimes change to a different nesting beach within a single nesting season (has switched to beach up to several hundred kilometers away) (see Eckert et al. 1989). Beach development and illumination often make beaches unsuitable for successful nesting (NatureServe, 2015). It is generally accepted that green sea turtles return to their natal beaches. Green sea turtles do exhibit strong site fidelity in successive nesting seasons (NMFS, 1991)

Dispersal/Migration

Motility/Mobility

Adult: High (NatureServe, 2015)

Migratory vs Non-migratory vs Seasonal Movements

Adult: Migratory (NatureServe, 2015)

Dispersal

Adult: High (NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Adults migrate up to about 3,000 km between nesting beaches and feeding areas (e.g., between Ascension Island and the South American coast). See Balazs (1982) for a map of documented migrations between the major nesting area in Hawaii (French Frigate Shoals) and foraging areas elsewhere in the Hawaiian Islands. See Morreale and Standora (no date) for information on movements along the east coast of the United States. Seminoff et al. (2002) documented migration between nesting area on the coast of Michoacan (Mexico; January 2000) and a feeding ground on the Sonoran coast of the Gulf of California (Mexico; September 2000). See Mortimer and Porter (1989) for information on inter-nesting movements at Ascension Island. Neonates migrate far from natal beaches to foraging areas and return to natal beach to breed/nest up to 40+ years later (NatureServe, 2015).

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Number of Populations:

81 to >300 (NatureServe, 2015)

Population Size:

100,000 to >1,000,000 individuals (NatureServe, 2015). South Atlantic DPS 63,332 nesting females (NMFS, 2016)

Resistance to Disease:

Moderate (USFWS, 1991)

Population Narrative:

Number of subpopulations and especially population size undoubtedly have undergone a major decline over the long term. Decline of 30-70% At 46 nesting areas worldwide, representing most but not all of the global population, the latest data indicate that approximately 109,000-151,000 females nest each year (NMFS and USFWS 2007). Assuming an average remigration interval of 3 years, this indicates an adult female population size of roughly 327,000-453,000. Assuming an equal number of adult males yields 654,000-906,000 adults for this subset of the global population. This species is represented by a large number of nesting occurrences (more than 150 major and minor nesting areas in more than 80 nations worldwide) (NatureServe, 2015). High resiliency, redundancy and representation are based on the overall number of individuals in the DPS and the geographic range that the species inhabits. Fibropapillomas are common on immature green sea turtles in the Indian River population (USFWS, 1991). Though there is some evidence that the South Atlantic DPS is increasing, there is a considerable amount of uncertainty over the impacts of threats to the South Atlantic DPS. The DPS is threatened by habitat degradation at nesting beaches, and mortality from fisheries bycatch remains a primary concern (NMFS Chlorpyrifos, Diazinon, and Malathion BiOp, 2017). Abundance: Worldwide, nesting data at 464 sites indicate that 563,826 to 564,464 females nest each year. The South Atlantic DPS has 51 nesting sites, with an estimated nester abundance of 63,332. The largest nesting site is at Poilão, Guinea-Bissau, which hosts 46% of nesting females for the DPS (Seminoff et al. 2015).

Productivity / Population Growth Rate: There are fifty-one nesting sites for the South Atlantic DPS, and many have insufficient data to determine population growth rates or trends. Of the nesting sites where data are available, such as Ascension Island, Suriname, Brazil, Venezuela, Equatorial Guinea, and Guinea-Bissau, there is evidence that population abundance is increasing (Seminoff et al. 2015). Genetic Diversity: Individuals from nesting sites in Brazil, Ascension Island, and western Africa have a shared haplotype found in high frequencies. Green turtles from rookeries in the eastern Caribbean however, are dominated by a different haplotype (Seminoff et al. 2015) (NMFS Chlorpyrifos, Diazinon, and Malathion BiOp, 2017).

Threats and Stressors

Stressor: Beach erosion (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of habitat/Loss of nests
Narrative: Erosion of nesting beaches can result in partial or total loss of suitable nesting habitat. Erosion rates are influenced by dynamic coastal processes, including sea level rise. Man's interference with these natural processes through coastal development and associated activities has resulted in accelerated erosion rates and interruption of natural shoreline migration (USFWS, 1991).

Stressor: Beach armoring (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Where beachfront development occurs, the site is often fortified to protect the property om erosion. Virtually all shoreline engineering is carried out to save structures, not dry sandy beaches, and ultimately results in environmental damage (USFWS, 1991).

Stressor: Beach nourishment (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Beach nourishment consists of pumping, trucking, or scraping sand onto the beach to rebuild what has been lost to erosion. Beach nourishment can impact turtles through direct burial of nests and by disturbance to nesting turtles if conducted during the nesting season. Sand sources may be dissimilar from native beach sediments and can affect nest site selection, digging behavior, incubation temperature (and hence sex ratios), gas exchange parameters within incubating nests, hydric environment of the nest, hatching success and hatchling emergence success (Mann, 1977; Ackerman, 1980; Mortimer, 1982b; Raymond, 1984a). Beach nourishment can result in severe compaction or concretion of the beach. Trucking of sand onto project beaches may increase the level of compaction (USFWS, 1991).

Stressor: Artificial lighting (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of habitat/misorientation

Narrative: Extensive research has demonstrated that the principal component of the sea-finding behavior of emergent hatchlings is a visual response to light (Daniel and Smith, 1947; Hendrichon, 1958; Carr and Ogren, 1960; Ehrenfeld and Carr, 1967; Dickerson and Nelson, 1989; Witherington, 1989). Artificial beachfront lighting from buildings, streetlights, dune crossovers, vehicles and other types of beachfront lights have been documented in the disorientation (loss of bearings) and misorientation (incorrect bearing) of hatchling turtles (McFarlane, 1963; Philibosian, 1976; Mann, 1977; 1980; Ehrhart, 1983). The results of misorientation are often fatal. As hatchlings head toward lights or meander along the beach their exposure to predators and likelihood of desiccation is greatly increased. Misoriented hatchlings can become entrapped in vegetation or debris, and many hatchlings are found dead on nearby roadways and in parking lots after being struck by vehicles. Hatchlings that successfully find the water may be misoriented after entering the surf zone or while in nearshore waters. Intense artificial lighting can even md raw hatchlings back out of the surf (Daniel and Smith, 1947; Carr and Ogren, 1960). During 1988 alone, 10,155 misoriented hatchlings were reported to the FDNR. An unquantifiable number of additional disorientation and misorientation events undoubtedly occurred but were not documented due to depredation, entrapment in thick vegetation, loss in storm drains, or obliteration of carcasses by vehicle tires. The problem of artificial beachfront lighting is not restricted to hatchlings. Carr et al (15)78), Mortimer [1982b), and Witherington (1986) found that adult green turtles avoided bright areas on nesting beaches. Problem lights may not be restricted to those placed directly on or in close proximity to nesting beaches. %e background glow associated with intensive inland lighting, such as that emanating from nearby large metropolitan areas, may deter nesting females and misorient hatchlings navigating the nearshore haters. Cumulatively, along the heavily developed beaches of the southeastern United States, the negative effects of artificial lights are profound (USFWS, 1991).

Stressor: Beach cleaning (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of habitat/loss of nests
Narrative: Beach cleaning refers to the removal of both abiotic and biotic debris from developed beaches. There are several methods employed including mechanical raking, hand raking and hand picking up of debris. Mechanical raking can result in heavy machinery repeatedly traversing nests and potentially compacting sand above nests and also results in tire ruts along the beach which may hinder or trap emergent hatchlings. Mann (1977) suggested that mortality within nests may increase when externally applied pressure from beach cleaning machinery is common on soft beaches with large grain sands. Mechanically pulled rakes and hand rakes can penetrate the surface and disturb the sealed nest or may actually uncover pre-emergent hatchlings near the surface of the nest. In some areas collected debris is buried directly on the beach, and this can lead to excavation and destruction of incubating egg clutches. Disposal of debris near the dune line or on the high beach can cover incubating egg clutches and subsequently hinder and entrap emergent hatchlings and may alter natural nest temperatures. In some areas, mechanical beach cleaning is the sole reason for extensive nest relocation (USFWS, 1991).

Stressor: Increased human presence (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of habitat/loss of nests/misorientation

Narrative: Residential and tourist use of developed (and developing) nesting beaches can result in negative impacts to nesting turtles, incubating egg clutches, and hatchlings. The most serious threat caused by increased human presence on the beach is the disturbance to nesting females. Night-time human activity can cause nesting females to abort nesting attempts at all stages of the behavioral process. Murphy (1985) reported that disturbance can cause turtles to shift their nesting beaches, delay egg laying and select poor nesting sites. Heavy utilization of nesting beaches by humans (pedestrian traffic) may result in lowered hatchling emergence success rates due to compaction of sand above nest (Mann, 1977), and pedestrian tracks can interfere with the ability of hatchlings to reach the ocean (Hosier et al., 198 1). Campfires and the use of flashlights on nesting beaches misorient hatchlings and can deter nesting females (Mortimer, 1979) (USFWS, 1991).

Stressor: Recreational beach equipment (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals/loss of nests
Narrative: The placement of physical obstacles (e.g., lounge chairs, cabanas, umbrellas, hobie cats, canoes, small boats, beach cycles) on nesting beaches can hamper or deter nesting attempts and interfere with incubating egg clutches and the sea approach of hatchlings. The documentation of false crawls at these obstacles is becoming increasingly common as more recreational beach equipment is left in place nightly on nesting beaches. Additionally, there are documented reports of nesting females becoming entrapped under heavy wooden lounge chairs and cabanas on south Florida nesting beaches (J. Hoover, pers. comm., S. Bass, pers. comm). The placement of recreational beach equipment directly above incubating egg clutches may hamper hatchlings during emergence and can destroy eggs through direct invasion of the nest (C. LeBuff, pers. comm.) (USFWS, 1991).

Stressor: Beach vehicular driving (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of nests/loss of individuals
Narrative: The operation of motor vehicles on nesting beaches for recreational purposes is permitted in northeast Florida (portions of Nassau, Duval, St. John's, Flagler and Volusia counties), northwest Florida (Walton and Gulf Counties), and North Carolina (Emerald Isle, Cape Lookout National Seashore, Cape Hatteras National Seashore and Currituck Banks). While some areas restrict night driving, others permit it. Driving on beaches at night during the nesting season can disrupt the nesting process and result in aborted nesting attempts. The negative impact on nesting females in the surf zone may be particularly severe. Vehicle headlights can disorient or misorient emergent hatchlings and vehicles can strike and kill hatchlings attempting to reach the ocean. The tracks or ruts left by vehicles traversing the beach interfere with the ability of hatchlings to reach the ocean. The extended period of travel required to negotiate tire tracks and ruts may increase the susceptibility of hatchlings to stress and depredation during transit to the ocean (Hosier et d., 1981; M. Evans, FDNR, pers. comm.). Driving directly above incubating egg clutches can cause sand compaction which may decrease nest success and directly kill pre-emergent hatchlings (Mann, 1977). In many areas, beach vehicular driving is the sole cause for nest relocation. Additionally, vehicle traffic on nesting beaches contributes to erosion, especially during high tides or on narrow beaches where driving is concentrated on the high beach and foredune (USFWS, 1991).

Stressor: Exotic dune and beach vegetation (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Non-native vegetation has invaded many coastal areas and often outcompetes native species such as sea oats, railroad vine, sea grape, dune panic grass and pennywort. The invasion of less stabilizing vegetation can lead to increased erosion and degradation of suitable nesting habitat. Exotic vegetation may also form impenetrable root mats which can prevent proper nest cavity excavation, invade and desiccate eggs or trap hatchlings (USFWS, 1991).

Stressor: Nest depredation (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of nests
Narrative: A variety of natural and introduced predators such as raccoons, feral hogs, foxes, ghost crabs and ants prey on incubating eggs and hatchling sea turtles. The principal predator is the raccoon (Procyon lotor). Raccoons are particularly destructive and may take up to 96 percent of all nests deposited on a beach (Davis and Whiting, 1977; Hopkins and Murphy, 1980; Stancyk et al., 1980; Talbert et al., 1980; Schroeder, 1981; Labisky et al., 1986). Prior to hog control efforts, up to 45 percent of all sea turtle nests deposited at the Cape Canaveral Air Force Station, Florida, were depredated by feral hogs (FDNR, unpubl. data). In addition to the destruction of eggs, certain predators may take considerable numbers of hatchlings just prior to or upon emergence from the sand (USFWS, 1991).

Stressor: Nest Loss and Abiotic Factors (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of nests
Narrative: Nest loss due to erosion or inundation and accretion of sand above incubating nests appear to be the principal abiotic factors which may negatively affect incubating: egg clutches. while these factors are often widely perceived as contributing significantly to nest mentality or lowering hatching success, few quantitative studies have been conducted (Mortimer, 1989). Studies on a relatively undisturbed nesting beach by Witherington (1986) indicated that excepting a late season severe storm event, erosion and inundation played a relatively minor role in destruction of incubating nests. Inundation of nests and accretion of sand above incubating nests as a result of a late season storm played a major role in destroying nests from which hatchlings had not yet emerged. Severe storm events (e.g., tropical storms, hurricanes) may result in significant nest loss, but these events are typically aperiodic rather than annual occurrences. In the southeastern United States, severe storm events are generally experienced after the peak of the hatching season and hence would not be expected to affect the majority of incubating nests. Erosion and inundation of nests is exacerbated through coastal development and shoreline engineering. These threats are discussed above under beach armoring (USFWS, 1991).

Stressor: Poaching (USFWS, 1991)
Exposure:
Response:

Consequence: Loss of individuals
Narrative: In the United States, take of nesting female green turtles is infrequent. However, in a number of areas, egg poaching and clandestine markets for eggs are not uncommon. During the period 1983 - 1989 the Florida Marine Patrol made 29 arrests for illegal possession of turtle eggs (figure: not apportioned by species) (USFWS, 1991). Illegal directed harvesting of juvenile and adult green turtles in the waters of the continental United States and U.S. Caribbean is not uncommon, but no estimates of the level of take exist. During the period 1983-1989, the Florida Marine Patrol made three arrests for illegal possession of whole turtles and 25 arrests for illegal possession of turtle parts within Florida (figures are not apportioned by species). Illegal take of green turtles in the United States Caribbean, particularly in Puerto Rican waters, is likely the most significant problem (USFWS, 1991).

Stressor: Oil and gas exploration, development and transportation (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Experimental and field results reported by Vargo pt al. (1986) indicate that marine turtles would be at substantial risk if they encountered an oil spill or large amounts of tar in the environment. Physiological experiments indicate that the respiration, skin, some aspects of blood chemistry and composition, and salt gland function of marine turtles are significantly affected (Vargo et al., 1986). Spills in the vicinity of nesting beaches are of special concern and could place nesting adults, incubating egg clutches (Fritts and McGehee, 1989) and hatchlings at significand risk. Exploration and oil development on live bottom areas may disrupt foraging grounds by smothering benthic organisms with sediments and drilling muds (Coston-Clements and Hoss, 1983). Oil and tar are also released into the marine environment during pumping of bilges on large vessels. In a review of available information on debris ingestion, Balazs (1985) reported that tar balls were the second most prevalent type of abiotic debris ingested by marine turtles (USFWS, 1991).

Stressor: Dredging (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: The effects of dredging are evidenced through direct destruction or degradation of habitat and incidental take of marine turtles. Channelization of inshore and nearshore habitat and the disposal of dredged material in the marine environment can destroy or disrupt resting or foraging grounds (including grass beds and coral reefs) and may affect nesting distribution through the alteration of physical features in the marine environment (Hopkins and Murphy, 1980). Hopper dredges are responsible for incidental take and mortality of marine turtles during dredging operations. During a 3-month period in 1980 in the Port Canaveral, Florida, channel, dredging operations were responsible for the mortality of approximately 100 turtles. These high levels of incidental take have not been documented during dredging operations in subsequent years. Maintenance dredging of the Kings Bay, Georgia, channel during 1987-1988 resulted in the mortality of approximately 20 turtles during a 1 year period. Other types of dredges (clamshell and pipeline) have not been implicated in incidental take (USFWS, 1991).

Stressor: Marina and dock development (USFWS, 1991)
Exposure:

Response:
Consequence: Loss of habitat/loss of individuals
Narrative: The development of marinas and private or commercial docks in inshore waters can negatively impact turtles through destruction or degradation of foraging habitat. Additionally, this type of development leads to increased boat and vessel traffic which may result in higher incidences of propeller- and collision-related mortality. Fueling facilities at marinas can result, in the discharge of oil and gas into sensitive estuarine habitat (USFWS, 1991).

Stressor: Pollution (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of habitat/decreased nesting success
Narrative: The effects of pollutants resulting from industrial, agricultural or residential sources are difficult to evaluate. Pesticides, heavy metals and PCB's have been detected in turtles (including eggs), but levels which result in adverse effects have not been quantified (Nelson, 1988) (USFWS, 1991).

Stressor: Seagrass bed degradation (USFWFS, 1991)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Boating activities in areas of seagrass beds can result in damage through anchoring and propeller scarring. In the United States Virgin Islands, seagrasses recovered only minimally in areas damaged by anchoring even after a period of seven months (Williams, 1988), and a decline in seagrass distribution was documented over a 30-year period in selected bays. The loss of available foraging habitat resulted in a lowered carrying capacity for specific bays (Williams, 1988). Extensive die-offs of seagrass beds in Florida Bay have recently been reported, and this may have serious consequences for the green turtles which forage there. The cause(s) of that decline have not yet been identified (USFWS, 1991).

Stressor: Trawl fisheries (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Of all commercial and recreational fisheries conducted in the United States, shrimp trawling is the most damaging to the recovery of marine turtles. The estimated number of green turtles captured annually is approximately 925 of which approximately 225 die (T. Henwood, pers. comm.). Incidental capture and drowning in shrimp trawls is believed to be the largest single source of mortality on juvenile through adult stage marine turtles in the southeastern United States. The majority of these turtles are juveniles and subadults, the age/size classes most critical to the stability and recovery of marine turtle populations (Crouse et al., 1987). Quantitative estimates of turtle take by shrimp trawlers in inshore waters have not been developed, but the level of trawling effort expended in inshore waters along with increasing documentation of the utilization of inshore habitat by green turtles suggest that capture and mortality may be significant. Trawlers targeting species other than shrimp tend to use larger nets than shrimp trawlers and probably also take sea turtles, although capture levels have not been developed. These fisheries include, but are not limited to, bluefish, croaker, flounder, calico scallops, blue crab, and whelk. Of these, the bluefish, croaker, and flounder trawl fisheries likely

pose the most serious threat (T. Henwood, pers. comm) (USFWS, 1991).

Stressor: Purse seine fisheries (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Several purse seine fisheries operate in Gulf of Mexico and Atlantic, including those targeting menhaden and sardines. Turtles may be taken in these fisheries, but the level of take and percent mortality is currently unquantified (USFWS, 1991).

Stressor: Hook and line fisheries (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Several thousand commercial vessels are engaged in hook and line fisheries which target various species including coastal species, reef fish, and pelagic species. In addition to commercial take, the recreational fishery is extensive. Turtle captures on hook and line gear are not uncommon, but the level of take and percent mortality are unknown. It is assumed that most turtles are released alive, although ingested hooks and entanglement in associated monofilament/steel line have been documented as the probable cause of death in some stranded turtles (USFWS, 1991).

Stressor: Gill net fisheries (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Gill nets are utilized both in inshore and offshore areas for various species and may be stationary or drifting. Mesh size is dependent on the size of the fish which are targeted but the gear is considered non-selective in the species impacted (T. Henwood, pers. comm.). Trammel nets are modified gill nets set in panels of webbing of variable mesh size. Marine turtles are vulnerable to entanglement and drowning in gill and trammel nets, especially when this gear is left unattended. turtle mortalities resulting from the use of gill nets set for sturgeon in South Carolina and North Carolina have been documented (Ulrich, 1978; Crouse, 1982). In response to this documented take, the state of South Carolina has prohibited gill netting for sturgeon since 1986. Of particular concern are the gill net and trammel net fisheries off the Florida east-central coast. These fisheries, primarily targeting king mackerel, pompano, and shark have undergone recent expansion in the number of vessels and level of fishing effort (Schaefer et d., 1987). Stranding patterns of turtles in this area indicate that significant numbers of turtles may be killed incidental to these fisheries. This may be particularly detrimental to the juvenile green turtle population(s) inhabiting this coastal area. (USFWS, 1991).

Stressor: Pound net fisheries (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: York, and Rhode Island. In Virginia, pound nets have been identified as a leading cause of marine turtle mortality (Lutcavage and Musick, 1985). Mortality was principally caused by entanglement and drowning in the leader portion of the gear and was dependent on mesh size.,

net location, and environmental parameters. In North Carolina, most pound nets have leads constructed of small mesh (5-8"). Results of preliminary investigations indicate that mortality in these nets may be infrequent (Epperly and Veishlow, 1989). Similarly, in New York, most turtles are released alive from pound nets and entanglement in leaders appears infrequent (V. Burke, pers. comm.) (USFWS, 1991).

Stressor: Longline fisheries (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Longline fisheries have increased dramatically over the past several years. Species targeted in these fisheries include tuna, shark, and swordfish. Witzell (1987) estimated that 330 turtles were incidentally captured in the Gulf of Mexico and Atlantic by the Japanese tuna longline fleet during 1978-1981. Due to increased effort and expansion of longline fisheries in recent years, it is believed that longline fisheries may be exerting a major negative impact on marine turtle recovery (T. Henwood, pers. comm.) (USFWS, 1991).

Stressor: Trap fisheries (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Traps are commonly used in the capture of crabs, lobster, and reef fish. Traps vary in size and configuration but all are attached to a surface float by means of a line leading to the trap. Turtles can become entangled in trap lines below the surface of the water and subsequently drown. In other instances, stranded turtles have been recovered entangled in trap line with the trap in tow. The impact of this gear on green turtle populations has not been quantified (USFWS, 1991).

Stressor: Boat collisions (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Propeller and collision injuries to marine turtles from boats and ships are not uncommon. In 1986, 1987, and 1988, respectively 5.8 percent (1 1 l), 7.3 percent (175), and 9.0 percent (179) of all stranded turtles reported in the United States Gulf of Mexico and Atlantic were documented as having sustained some type of propeller or collision injuries, although it is unknown what percentage of these injuries were post-mortem versus ante-mortem (Schroeder and Warner, 1988; Teas and Martinez, 1989). These types of injuries are recorded at higher frequencies in areas where recreational boating and vessel traffic is intense, such as south Florida, the Florida Keys and United States Virgin Islands (USFWS, 1991).

Stressor: Power plant entrapment (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: The entrainment and entrapment of turtles in saltwater cooling intake systems of coastal power plants has been documented in New Jersey, North Carolina, Florida, and Texas (Roithmayr and Henwood, 1982; Ernest et d; 1989; S. Manzella, pers. comm; T. Henson, pers.

comm.; R. Schoelkopf, pers. comm.). Average annual incidental capture rates for most coastal plants from which captures have been reported amount to several turtles per plant per year. One notable exception is the St. Lucie nuclear power plant located on Hutchinson Island, Florida. During a 13-year period of operation (March 1976 - December 1988), 1,929 turtles of all species have been removed from the intake canal. The mortality rate is approximately 7.0 percent (Applied Biology, Inc., unpubl. data). Most captures have been loggerheads, though green turtles are not uncommon. (USFWS, 1991).

Stressor: Underwater explosions (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: The use of underwater explosives for the removal of abandoned oil platforms, military activities, and oil exploration can injure or kill turtles and may destroy or degrade habitat. During a 3-year period (1986-1988) observers reported one injured (or dead) turtle during the removal of 103 offshore oil structures in the Gulf of Mexico. Of eight turtles deliberately exposed to underwater explosions at distances varying between 229 m and 915 m from the detonation site, five were rendered unconscious (Klima et al; 1989) (USFWS, 1991).

Stressor: Offshore artificial lighting (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of habitat/misorientation
Narrative: The effects of offshore lighted structures on the orientation of hatchling turtles is not completely understood. These lights may attract hatchlings and interfere with proper offshore orientation, and may make them more susceptible to predation (deSilva, 1982) (USFWS, 1991).

Stressor: Entanglement (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Turtles are affected to an unknown but potentially significant degree by entanglement in persistent marine debris, including discarded or lost fishing gear (Balazs, 1985). Green turtles have been found entangled in a wide variety of materials including steel and monofilament line, synthetic and natural rope, plastic onion sacks and discarded plastic netting materials (Balazs, 1985; Plotkin and Amos, 1988). Monofilament line appears to be the principal source of entanglement for green turtles in U.S. waters. Records from Florida and the United States Virgin Islands indicate that some entanglement results from netting and monofilament line which has accumulated on both artificial and natural reefs. These areas are often heavily fished, resulting in snagging of hooks and discarding of lines. Turtles foraging and/or resting in these areas can become entangled and drown (FDNR, unpubl. data). 'The alignment of persistent marine debris along convergences, rips, and driftlines and the concentration of young sea turtles along these fronts increases the likelihood of entanglement at this life history stage (Carr, 1987) (USFWS, 1991).

Stressor: Ingestion of marine debris (USFWS, 1991)
Exposure:
Response:

Consequence: Loss of individuals
Narrative: Marine turtles have been found to ingest a wide variety of abiotic debris items such as plastic bags, raw plastic pellets, plastic and styrofoam pieces, tar balls and balloons. Effects of debris ingestion can include direct obstruction of the gut, absorption of toxic byproducts and reduced absorption of nutrients across the gut wall (Balazs, 1985). Studies conducted by Lutz (in press) revealed that both loggerhead and green turtles actively ingested small pieces of latex and plastic sheeting. Physiological data indicated a possible interference in energy metabolism or gut function, even at low levels of ingestion. Persistence of the material in the gut lasted from a few days to 4 months (Lutz, in press). Of particular concern is the co-occurrence of persistent marine debris and the early life history pelagic stages of green turtles along convergences. Young turtles are dependent upon these driftlines for their food supply, and hence the likelihood of debris ingestion is increased (Carr, 1987). While quantitative data on population effects are undetermined, the impacts of debris ingestion are considered serious (USFWS, 1991).

Stressor: Disease and parasites (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: There is little information available to assess the comprehensive effects of disease and/or parasites on wild populations of green turtles. The vast majority of diseases and conditions which have been identified or diagnosed in sea turtles are described from captive stock, either turtles in experimental headstart programs or mariculture facilities (Wolke, 1989). One notable exception is the occurrence of fibropapillomas on green turtles, first described by Smith and Coates (1938). Fibropapillomas are now common on immature green turtles in the central Indian River system of Florida, Florida Bay, and in the Florida Keys (Ehrhart et al., 1986; Witherington and Ehrhart, 1987; Schroeder, 1987a). In the central Indian River lagoon, approximately half of all green turtles captured have been found to bear papillomas of varying degree (Ehrhart et al., 1986). Recent reports from Puerto Rico and the United States Virgin Islands indicate a very low occurrence of fibropapillomas on green turtles collected in these areas (R. Boulon and J. Collazo, pers. comm.). Fibropapillomas are also commonly found on Hawaiian green turtles. These tumor like growths can result in reduced vision, disorientation, blindness, physical obstruction to normal swimming and feeding, an apparent increased susceptibility to parasitism by marine leeches, and an increased susceptibility to entanglement in monofilament fishing line (Balazs, 1986). Blood counts and serum profiles of green turtles inflicted with fibropapillomas indicate marked debilitation (Jacobson, 1987) (USFWS, 1991).

Stressor: Predation (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Predation of hatchling and very young turtles is assumed to be significant and predation of subadult through adult stage turtles is assumed less common, but valid estimates of mortality due to predation at various life history stages are extremely difficult, if not impossible, to obtain and have not been determined. Hatchlings entering the surf zone and pelagic stage hatchlings may be preyed upon by a wide variety of fish species and to a lesser extent, marine birds. Stancyk (1982) in an extensive literature review reported predators of juvenile and adult turtles to include at least six species of sharks, killer whales, bass, and grouper. Tiger sharks appear to be the principal predator of subadult and adult turtles. While stranded turtles may

exhibit shark inflicted injuries, caution must be exercised in attributing a cause of death as these wounds can be inflicted post-mortem (USFWS, 1991).

Recovery

Delisting Criteria:
The United States population of green turtles can be considered for delisting if, over a period of 25 years, the following conditions are met: 1. The level of nesting in Florida has increased to an average of 5,000 nests per year for at least 6 years. Nesting data must be based on standardized surveys (USFWS, 1991).

2. At least 25 percent (105 km) of all available nesting beaches (420 km) is in public ownership and encompasses at least 50 percent of the nesting activity (USFWS, 1991).

3. A reduction in stage class mortality is reflected in higher counts of individuals on foraging grounds (USFWS, 1991).

4. All priority one tasks have been successfully implemented (USFWS, 1991).

Recovery Actions:
- 1. Protect and manage habitats. 11. Protect and manage nesting habitat. 111. Ensure beach nourishment projects are compatible with maintaining good quality nesting habitat. (also see 215). 1111. Implement and evaluate tilling as a means of softening compacted beaches. 1112. Evaluate the relationship of sand characteristics (including aragonite) and hatch success, hatchling sex ratios, and nesting behavior. 1113. Reestablish dunes and native vegetation. 1114. Evaluate sand transfer systems as alternative to beach nourishment. 112. Prevent degradation of nesting habitat from seawalls, revetments, sand bags, sand fences, or other erosion control measures. 1121. Evaluate current laws on beach armoring and strengthen if necessary. 1122. Ensure laws regulating coastal construction and beach armoring are enforced. 1123. Ensure failed erosion control structures are removed. 1124. Develop standard requirements for sand fence construction. 113. Acquire or otherwise ensure the long-term protection of key nesting beadles. 1131. Acquire in fee title all undeveloped nesting beaches between Melbourne Beach and Wabasso Beach, Florida. 1132. Evaluate the status of the important nesting beaches on Hutchinson Island, Florida, and develop a plan for long-term protection. 114. Remove exotic vegetation and prevent spread to nesting beaches. 12. Protect marine habitat. 121. Identify important habitat. 122. Prevent degradation and improve water quality of important turtle habitat. 123. Prevent destruction of habitat from fishing gears and vessel anchoring. 124. Prevent destruction of marine habitat from oil and gas activities. 125. Prevent destruction of habitat from dredging activities. 126. Restore important foraging habitats (USFWS, 1991).
- 2. Protect and manage population. 21. Protect and manage populations on nesting beaches. 211. Monitor trends in nesting activity by means of standardized surveys. 212. Evaluate nest success and implement appropriate nest protection measures. 213. Determine influence of factors such as tidal inundation and foot traffic on hatching success. 214. Reduce effects of artificial lighting on hatchlings and nesting females. 2141. Determine hatchling orientation mechanisms in the marine environment and assess dispersal patterns from natural (dark) beaches and beaches with high levels of artificial lighting. 2142. Implement and enforce lighting ordinances. 2143. Evaluate extent of hatchling disorientation on all important

regional nesting beaches. 2144. Evaluate need for Federal lighting regulations. 2145. Develop lighting plans at Kennedy Space Center, Port Canaveral, Cape Canaveral Air Force Station and Patrick Air Force Base, Florida. 2146. Prosecute individuals or entities responsible for hatchling disorientation or misorientation under the Endangered Species Act or appropriate State laws. 215. Ensure beach nourishment and coastal construction activities are planned to avoid disruption of nesting and hatching activities. 216. Ensure law enforcement activities eliminate poaching and harassment. 217. Determine natural hatchling sex ratios. 22. Protect and manage populations in the marine environment. 221. Determine green turtle distribution, abundance and status in the marine environment. 2211. Determine seasonal distribution, abundance, population characteristics, and status in bays, sounds and other important nearshore habitats. 2212. Determine adult navigation mechanisms, migratory pathways, distribution and movements between nesting seasons. 2213. Determine present or potential threats to green turtles along migratory routes and on foraging grounds. 2214. Determine breeding population origins for U.S. juvenile/subadult populations. 2215. Determine growth rates, age of sexual maturity and survivorship rates of hatchlings, juveniles, and adults. 222. Monitor and reduce mortality from commercial and recreational fisheries. 2221. Implement and enforce TED regulations in all United States waters at all times. 2222. Provide technology transfer for installation and use of TEDs. 2223. Maintain the Sea Turtle Stranding and Salvage Network. 2224. Identify and monitor other fisheries that may be causing significant mortality. 2225. Promulgate regulations to reduce fishery related mortalities. 223. Monitor and reduce mortality from dredging activities. 2231. Monitor turtle mortality on dredges. 2232. Evaluate modifications of dredge dragheads or devices to reduce turtle captures, and incorporate effective modifications or devices into future dredging operations. 2233. Determine seasonality and abundance of sea turtles at dredging localities, and ensure that dredging is restricted to time periods with the least potential for turtle mortality. 224. Monitor and prevent adverse impacts from oil and gas activities. 2241. Determine the effects of oil and oil dispersants on all life stages. 2242. Ensure that impacts to sea turtles are adequately addressed during planning of oil and gas development. 2243. Determine sea turtle distribution and seasonal use of marine habitats associated with oil and gas development areas. 224. Reduce impacts from entanglement and ingestion of persistent marine debris. 2251. Evaluate the extent of entanglement and ingestion of persistent marine debris. 2252. Evaluate the effects of ingestion of persistent marine debris on health and viability of sea turtles. 2253. Determine and implement appropriate measures to reduce or eliminate persistent marine debris in the marine environment. 226, Increase law enforcement efforts to reduce poaching in United States waters. 227, Determine etiology of fibropapillomatosis. 228. Centralize administration and coordination of tagging programs. 2281. Centralize tag series records. 2282. Centralize turtle tagging records. 229. Ensure proper care of sea turtles in captivity. 2291. Develop standards for care and maintenance including diet, water quality and tank size. 2292. Develop manual for treatment of disease and injuries. 2293. Establish catalog for all captive sea turtles to enhance utilization for research and education. 2294. Designate rehabilitation facilities (USFWS, 1991).

- 3. Information and education. 31. Provide slide programs and information leaflets on sea turtle conservation for general public. 32. Develop brochure on recommended lighting modifications or measures to reduce hatchling disorientation and misorientation. 34. Develop public service announcements regarding the sea turtle artificial lighting conflict, and disturbance of nesting activities by public nighttime beach activities. 34. Ensure facilities permitted to hold and display captive sea turtles have appropriate informational displays.

35. Post information signs at public access points on important nesting beaches (USFWS, 1991).

- 4. International cooperation. 41. Develop international agreements to ensure protection of life stages which occur in foreign waters (USFWS, 1991).

References

U.S. Fish and Wildlife Service. 2016. Endangered and Threatened Wildlife and Plants

Final Rule To List Eleven Distinct Population Segments of the Green Sea Turtle (Chelonia mydas) as Endangered or Threatened and Revision of Current Listings Under the Endangered Species Act. 81 FR 20057

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia.

USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/speciesProfile/. Accessed April 2016.

National Marine Fisheries Service. 2017. Biological Opinion on the Environmental Protection Agency's Registration of Pesticides containing Chlorpyrifos, Diazinon, and Malathion. Consultation Tracking number: FPR-2017-9241. Digital Object Identifier (DOI): https://doi.org/10.7289/V5CJ8BQM

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1991. Recovery Plan for the U.S. Population of Atlantic Green Turtle. National Marine Fisheries Service, Washington, D.C

NatureServe. 2015. NatureServe Central Databases. FESTF received dataset on 08_11_2015. Arlington, Virginia, U.S.A

National Marine Fisheries Service, Washington, D.C. U.S. Fish and Wildlife Service. 2016. Endangered and Threatened Wildlife and Plants

Final Rule To List Eleven Distinct Population Segments of the Green Sea Turtle (Chelonia mydas) as Endangered or Threatened and Revision of Current Listings Under the Endangered Species Act. 81 FR 20057.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A."

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1991. Recovery Plan for the U.S. Population of Atlantic Green Turtle. National Marine Fisheries Service, Washington, D.C. U.S. Fish and Wildlife Service. 2016. Endangered and Threatened Wildlife and Plants

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1991. Recovery Plan for the U.S. Population of Atlantic Green Turtle. National Marine Fisheries Service, Washington, D.C.

SPECIES ACCOUNT: *Clemmys muhlenbergii* (Bog (=Muhlenberg) turtle (Glyptemys))

Species Taxonomic and Listing Information

Listing Status: Threatened; Northeast Region (R5) (USFWS, 2015)

Physical Description

A small turtle.Carapace is light brown to black (may have yellowish or reddish areas on large scutes), strongly sculptured with growth lines, and has an inconspicuous keel; plastron is mainly dark brown to black; head is brown, with a large yellow or orange (sometimes red) blotch above and behind the tympanum (blotch may be divided); adult carapace length usually is 7.5-9 cm (up to 11.5 cm); hatchling carapace is 2.5-3.2 cm; male vent is posterior to the rear edge of the carapace and the plastron is concave (flat in female) (Ernst and Barbour 1989, Conant and Collins 1991). LENGTH:9 (NatureServe, 2015)

Taxonomy

The bog turtle was described as Testudo muhlenbergii by Schoepff (1801), from a specimen collected by Reverend Gotthilf Heinrich Ernst Muhlenberg. The type locality was “Pennsylvaniae”; the holotype was not designated and its location is unknown (Ernst and Bury 1977). Stejneger and Barbour (19 17) restricted the type locality to “Lancaster, Pennsylvania.” Fitzinger (1835) was the first to use the combination CIemmys muhlenbergii. Included in the synonymy ofC1emmy.s muhlenbergii are Emys biguttata (Say 1825), lacking a designated holotype, type locality “United States,” and restricted to the “vicinity of Philadelphia” by Schmidt (1953), and Clemmys nuchalis (Dunn 1917). The type specimen (American Museum of Natural History No. 8430) was collected by Dunn on August 17, 1916, on the “side of Yonahlossee Road, about 3 miles from Linville, North Carolina,” at an altitude of 4,200 feet (USFWS, 2001).

Current Range

Discontinuous, spotty distribution; New York (including remnant population at two sites in the Finger Lakes region), western Massachusetts, and western Connecticut southward to Pennsylvania, New Jersey, Maryland, and northern Delaware; southeastern Virginia through western and central North Carolina and extreme eastern Tennessee to western South Carolina and Georgia (Herpetol. Rev. 14:55). Large hiatus of about 250 miles between the northern populations and the southern populations. In the north, Maryland has the largest number of occurrences and turtles; only about 20 populations thought to be viable exist outside Maryland and New Jersey. In the south, most occurrences and turtles are in North Carolina and Virginia (only a few viable populations elsewhere). Sea level to 1280 m in the Appalachians; usually below 245 m in the north. Most populations occur on private property. Extirpated in western Pennsylvania and in the Lake George region of New York.

Critical Habitat Designated

No;

Life History

Feeding Narrative

Juvenile: Feeds opportunistically on insects, worms, slugs, crayfish, snails, and other small invertebrates; also amphibian larvae and fruits. Diet generally is dominated by insects. Apparently forages on land and in water (Bury 1979).; Food Habits: Invertivore (Adult, Immature)Most activity occurs from mid-April to late September in New Jersey and Pennsylvania. In some areas, including Pennsylvania and Delaware, there is an apparent peak in activity in May (see Bury 1979). Reportedly may estivate or at least reduce activity to a small area during hot summer periods (especially July-August). In North Carolina, radiotelemetry showed that turtles remained active through summer and fall whereas hand captures indicated primarily vernal activity (Herman and Fahey 1992). In Maryland, movement into and out of retreats was noted from November through March (Chase et al. 1989). Active during daylight hours, mostly from mid-morning to late afternoon or early evening. More active on cloudy days than on bright sunny days (Mitchell 1991). In early spring, activity occurs mainly at midday and in the afternoon; most active in the morning in late spring and summer (Mitchell 1991).; (NatureServe, 2015)

Adult: Feeds opportunistically on insects, worms, slugs, crayfish, snails, and other small invertebrates; also amphibian larvae and fruits. Diet generally is dominated by insects. Apparently forages on land and in water (Bury 1979).; Food Habits: Invertivore (Adult, Immature)Most activity occurs from mid-April to late September in New Jersey and Pennsylvania. In some areas, including Pennsylvania and Delaware, there is an apparent peak in activity in May (see Bury 1979). Reportedly may estivate or at least reduce activity to a small area during hot summer periods (especially July-August). In North Carolina, radiotelemetry showed that turtles remained active through summer and fall whereas hand captures indicated primarily vernal activity (Herman and Fahey 1992). In Maryland, movement into and out of retreats was noted from November through March (Chase et al. 1989). Active during daylight hours, mostly from mid-morning to late afternoon or early evening. More active on cloudy days than on bright sunny days (Mitchell 1991). In early spring, activity occurs mainly at midday and in the afternoon; most active in the morning in late spring and summer (Mitchell 1991).; (NatureServe, 2015)

Reproduction Narrative

Adult: Most researchers have reported a fairly even sex ratio. Although Klemens (1990, 1993a) found significantly more adult females than males at two of his Massachusetts study sites, subsequent fieldwork by A. Whitlock (pers. comm.) at these sites has produced more even sex ratios. J. L. Behler (pers. comm.) observed a I:2 male to female ratio at his southeastern New York study site (USFWS, 2001). Mating occurs from late April to early June. Lays clutch of 1-6 (usually 3-5) eggs in May, June, or July (occasionally August). Eggs hatch in about 6-9 weeks, late July to early September. In the north, hatchlings may not emerge from the nest until October or they may overwinter in the nest. Sexually mature in 5-8 years. Not all adult females produce clutches annually. No evidence of multiple clutches wihtin a single season.; Home range size averaged 1.3 ha in Pennsylvania, where the longest distance moved by any individual was 225 m (see Bury 1979). Home range was 0.04-ha to 0.24 ha in Maryland (Chase et al. 1989). Home range size averaged 0.52 ha (median 0.35 ha, range 0.02-2.26 ha, minimum convex polygon) in Virginia (Carter et al. 1999). Long-distance movements between wetlands were infrequently observed in southwestern Virginia (Carter et al. 2000). In North Carolina over somewhat less than 1 year, distances between relocations of radio-tagged turtles was 0-87 m (mean 24 m) for males, 0-62 m (mean 16 m) for females (Herman and Fahey 1992). Population density may exceed 110/ha in some areas (see Ernst and Barbour 1972). In Maryland, population density was 7-213/ha of wetland habitat; average was 44 individuals per site at 9 sites (Chase et al. 1989). Searches of suitable habitat in North Carolina and Delaware yielded 1 bog turtle per 1.8 to 4.2 hours of search (see Bury 1979). In Pennsylvania, patches of suitable habitat had 3 to 300 individuals, mostly around 30 (see Mitchell 1991). In the northern half of the range, other turtles most likely to occur in bog turtle habitat include the spotted turtle, painted turtle, and wood turtle. Eggs, young, and adults are preyed on by various Carnivora, opossums, and some wading birds. Juveniles are very secretive.; (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Habitat Narrative

Adult: Bog turtles inhabit slow, shallow, muck-bottomed rivulets of sphagnum bogs, calcareous fens, marshy/sedge-tussock meadows, spring seeps, wet cow pastures, and shrub swamps; the habitat usually contains an abundance of sedges or mossy cover. The turtles depend on a mosaic of microhabitats for foraging, nesting, basking, hibernation, and shelter (USFWS 2000). "Unfragmented riparian systems that are sufficiently dynamic to allow the natural creation of open habitat are needed to compensate for ecological succession" (USFWS 2000). Beaver, deer, and cattle may be instrumental in maintaining the essential open-canopy wetlands (USFWS 2000). Bog turtles commonly bask on tussocks in the morning in spring and early summer. They burrow into soft substrate of waterways, crawls under sedge tussocks, or enter muskrat burrows during periods of inactivity in summer (see Bury 1979). In Pennsylvania, bog turtles hibernated mainly in water and mud in muskrat burrows, and in mud bottom of marsh rivulets under 5-15 cm of water. In New Jersey, hibernacula were in subterranean rivulets or seepage areas where water flowed continuously from underground springs; turtles were under 5-55 cm of water and mud (see Ernst et al. [1989] for further details). In Maryland, larger population sizes were associated with sites with the following characteristics: circular basin with spring-fed pockets of shallow water, bottom substrate of soft mud and rock, dominant vegetation of low grasses and sedges, and interspersed wet and dry pockets; winter retreats were shallow, just below upper surface of frozen mud and/or ice (Chase et al. 1989). Studies in Maryland and Pennsylvania noted use of the lower portion of wetlands for overwintering. In Virginia, selected habitats included wet meadow, smooth alder edge, and bulrush; dry meadow and streams were avoided (Carter et al. 1999). Nests are in open and elevated ground in areas of moss, sedges, or moist earth (see Bury 1979). The turtles dig a shallow nest or lay eggs in the top of a sedge tussock.SPRING/SPRING BROOKBog/fen; HERBACEOUS WETLAND; Riparian; SCRUB-SHRUB WETLANDBurrowing in or using soil (NatureServe, 2015)

Dispersal/Migration

Motility/Mobility

Adult: Moderate (NatureServe, 2015)

Migratory vs Non-migratory vs Seasonal Movements

Adult: Migratory (NatureServe, 2015)

Dispersal

Adult: Low (natureServe, 2015)

Immigration/Emigration

Adult: Emigrates (USFWS, 2001)

Dispersal/Migration Narrative

Adult: May migrate about 200 m between winter hibernation site and upstream summer range in some areas (Ernst and Barbour 1972). Hibernating juveniles were found in a nesting area in New Jersey (Ernst et al. 1989).; Nonmigrant: Y; Local migrant: Y; Distant migrant: N; (NatureServe, 2015). Occasionally, individual bog turtles are found crossing roads a considerable distance from any apparently suitable habitat. These apparent long distance movements may result from emigration out of habitats declining in quality through disturbances or succession (USFWS< 2001).

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Number of Populations:

33 Extant meta-populations (USFWS, 2022)

Population Size:

2500 - 100,000 individuals (NatureServe, 2015)

Population Narrative:

Low fecundity and high mortality rate of young make populations slow to recover from population losses. Decline of 30-70% Southern population, based on known sites, has been estimated at about 2500-4000; inclusion of potential occurrences in apparently suitable habitat brings the estimate up to about 4000-6000. Most populations are small. Cryptic, hard to find even when present in good numbers; easily overlooked (Collins 1990). In the northern segment of the range, currently known from 360 sites (5 in Connecticut, 4 in Delaware, 71 in Maryland, 3 in Massachusetts, 165 in New Jersey, 37 in New York, and 75 in Pennsylvania). Some of these are parts of larger occurrences, so the number of distinct occurrences is less than the number of sites. See USFWS (1997, 2000) for information on status in each state in the northern part of the range. (NatureServe, 2015). The bog turtle was listed in 1997. Prior to listing, there was a historical range reduction (primarily in New York), but since the species was listed, significant progress has been made in finding new bog turtle wetlands/individual populations across the northern range. One hundred ninety-one individual populations were known at the time of listing, but since that time using the new definition of population, 317 individual populations have been located. Also using our current definitions, we are now aware of 330 extant bog turtle metapopulations (made up of 508 individual populations; 244 of the metapopulations are single, isolated populations) across the range. In addition, there has been no discernible range reductions since the time of the listing as bog turtles continue to occur throughout the northern population range with the majority of metapopulations found within the Delaware and Susquehanna-Potomac RUs. For example, Pennsylvania has 7 new individual populations in new

WBDHU 12-level watersheds. However, throughout the northern range, 37 individual populations are considered historical and likely extirpated as survey efforts have been unsuccessful in locating turtles, and 40 additional individual populations are considered extirpated due to no suitable habitat remaining across the range (USFWS, 2022).

Threats and Stressors

Stressor: Development (USFWS, 2001)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Development occurring in groundwater recharge areas results in increases in impervious surfaces and the number of wells, which can, in turn, lower water tables, affecting groundwater discharges into bog turtle habitats (in terms of both quantity and quality) and accelerating succession (Lowenstein in litt. 2000). Patterns of subsurface water flow can be altered by infrastructure construction and other development projects. Drilling under wetlands (e.g., to install utility lines or fiber optic cable) has the potential to disrupt the flow of water and even fracture bedrock and significantly impact a small wetland system (USFWS, 2001).

Stressor: Grazing (USFWS, 2001)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Although light grazing may be beneficial in controlling succession, intensive pasturing adds excessive nutrient loading from fecal material, results in significant soil disturbance, (which may accelerate exotic plant invasion), destroys the unique plant community by overgrazing, and will result in bog turtles being crushed. The type and density of grazers determines the effect on the habitat. For example, horses appear to cause more damage to a pasture than cows, animal for animal. Smith (in litt. 2000) has observed that horses “graze lower to the soil, like sheep, and this coupled with their hoofs somehow appear to damage the substrate more - areas become mud holes with only a few horses whereas it would take many more cows to inflict the same amount of damage.” (USFWS, 2001)

Stressor: Succession (USFWS, 2001)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Some of the most persistent and widespread problems associated with maintaining bog turtle habitat are succession of open meadows to wooded swamps, drainage and flooding of habitats through diversion or damming of feeder streams, chemical and heavy metal pollution, nutrient enrichment from fertilizer and septic runoff, and the establishment of alien plants. Disturbance of surface soils and degraded water quality may result in the establishment and spread of invasive wetland plant species such as the alien purple loosestrife (Lythrum salicaria) or native giant reed (Phrugmites australis). These aggressive species rapidly invade wetlands when areas of disturbance and/or impaired water quality are created. Favored colonization sites are the piles of excavated soil placed alongside ponds and ditches. After taking root in a disturbed microhabitat, these plants quickly spread into the adjacent wetlands, replacing a diverse botanical community with a dense monoculture. This monoculture is unsuitable for many

wetland species, including bog turtles (Klemens, 1990, 1993a). Other invasive species implicated in reducing the value of bog turtle habitats include reed canary grass (Phaluris arundinucea) and multiflora rose (Rosa multiflora) (USFWS, 2001).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2001)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Although some states have been successful in avoiding or minimizing encroachments (e.g., filling, ditching, draining, development) into bog turtle habitat, significant habitat degradation and fragmentation has resulted from indirect effects to wetlands caused by activities in the adjacent uplands. Despite the recognition of regulated upland buffers around wetlands (in all northern range states except Pennsylvania), activities that contribute to habitat loss, including development, farming, and placement of detention or storm water basins, are often allowed to proceed within the buffer. These activities can degrade water quality, accelerate succession, encourage the invasion and spread of exotic plants, and change wetland hydrology (USFWS, 2001).

Stressor: Illegal trade and collection (USFWS, 2001)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Exploitation of bog turtles for commercial or private use ranks second in threats to this species, after habitat loss. Their small size, attractive shell and coloration, and rarity make the bog turtle a prize eagerly pursued by unscrupulous collectors, both in the United States and overseas, resulting in illegal collecting for an illicit pet trade. Tryon (1989), Strong (1989), and Herman (1989b) described one incident where a series of southern Appalachian study sites was decimated by a group of collectors who had specifically traveled south to capture bog turtles. Apart from removing large numbers of adults, these collectors seriously compromised at least one long-term mark and recapture study site by removing marked turtles (Herman 1989b). Klemens (1991) reviewed reports of illegal collecting activities from Delaware, Massachusetts, Maryland, New Jersey, New York, North Carolina, and Pennsylvania. In 1975, the bog turtle was added to Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in order to monitor trade in the species. In 1992, the bog turtle was transferred from Appendix II to Appendix I due to the increased number of bog turtles being advertised for sale, the increased price being paid for individuals and pairs, and illegal trade not being reported under CITES (57 FR 7722, March 4, 1992). Both import and export permits are required from the importing and exporting countries before an Appendix I species can be transported, and an Appendix I species cannot be exported for primarily commercial purposes (USFWS, 2001)

Stressor: Disease and predation (USFWS, 2001)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Many of the primary predators on bog turtles and their nests are human commensals, i.e., they flourish in the presence of humans and the landscapes that they alter. This is particularly acute for species such as the bog turtle, which occurs primarily in agricultural

landscapes where the presence of raccoons, skunks, opossums, and crows can pose a significant threat. How significant a threat these subsidized species pose to bog turtles is hard to determine, although in certain populations it is speculated that predation of adults and eggs is a serious problem. At present, there are no substantiated reports of disease affecting a wild population of bog turtles, although at one site in Columbia County, New York (J.L. Behler, pers. comm) the number of dead turtles is cause for concern; eight dead bog turtles were collected during three visits to the site in 1988 and 1989 (A. Breisch, in Mt. 2000). A sick turtle removed from that population and held for several years in captivity tested positive for upper respiratory distress syndrome (URDS) upon necropsy (J. L. Behler, pers. comm.). Although this could indicate a health problem within that population, it is also possible that the turtle contracted this disease while in captivity. Disease issues have the potential to become a much larger threat to wild bog turtle populations as they are subjected to more handling by researchers or if manipulation of turtle populations is undertaken through the deliberate release into the wild of bog turtles from other areas, zoological collections, or those seized by law enforcement activities. It should be noted that thorough health screening of wild-caught bog turtles has not been a standard practice of researchers, although it may be warranted (Smith in iitt. 2001) (USFWS, 2001).

Recovery

Reclassification Criteria:
Recovery Priority Number: 12C (USFWS, 2022)

Delisting Criteria:
Long range protection is secured for at least 185 populations distributed among five recovery units: Prairie Peninsula/Lake Plain Recovery Unit (I 0), Outer Coastal Plain Recovery Unit (S), HudsoniHousatonic Recovery Unit (40), SusquehannaA’otomac Recovery Unit (50), and Delaware Recovery Unit (80) (USFWS, 2001).

Monitoring at five-year intervals over a 25-year period shows that these 185 populations are stable or increasing (USFWS, 2001).

Illicit collection and trade no longer constitute a threat to this species’ survival (USFWS, 2001).

Long-term habitat dynamics, at all relevant scales, are sufficiently understood to monitor and manage threats to both habitats and turtles, including succession, invasive wetland plants, hydrology, and predation (USFWS, 2001).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS x Continue working with conservation partners on land protection of core habitat, buffers and connecting corridors, and habitat restoration at priority sites. x Increase outreach to landowners to increase efforts on land protection and habitat restoration. x Continue to proactively identify new sites via use of qualified personnel and grant programs to identify and survey high quality potential habitat. x Complete phase 3 of the SSA, future condition of bog turtles, to inform recovery planning. x Update Recovery Plan, including re-evaluating the recovery criteria. x Continue development of the regional database to ensure greater efficiency with data use for future 5-Year Reviews and conservation planning efforts. x Continue with regional monitoring program for assessing habitat and populations to determine trends and success of recovery actions. x Conduct research on hydrology mechanisms at sites to help inform guidance for project reviews and habitat restoration. x Coordinate a program with law enforcement to address poaching concerns, including building a genetic library to determine origin of collections. x Conduct research on climate change to better understand how bog turtles may be impacted in the future and to inform recovery actions. x Develop guidance and best management practices for various project activities (e.g., road and pipeline projects) during the environmental review process that are compatible with bog turtle conservation and for conservation purposes (e.g., radio-telemetry, predator control). x Conduct research on the effects of agriculture, including contaminants of emerging concern, to determine if any impacts are occurring at sites. x Continue to implement nest protection and perform predator control, where possible (USFWS, 2022).

References

U.S. Fish and Wildlife Service. 2001. Bog Turtle (Clemmys muhlenbergii), Northern Population, Recovery Plan. Hadley, Massachusetts. 103 pp

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A." USFWS. 2022. Bog Turtle (Glyptemys muhlenbergii) 5-Year Review: Summary and Evaluation. New York Field Office. Cortland, New York. 39 pp.

U.S. Fish and Wildlife Service. 2001. Bog Turtle (Clemmys muhlenbergii), Northern Population, Recovery Plan. Hadley, Massachusetts. 103 pp.

USFWS. 2022. Bog Turtle (Glyptemys muhlenbergii) 5-Year Review: Summary and Evaluation. New York Field Office. Cortland, New York. 39 pp.

SPECIES ACCOUNT: *Crocodylus acutus* (American crocodile)

Species Taxonomic and Listing Information

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

Physical Description

The American crocodile is a large greenish-gray reptile. At hatching, crocodiles are yellowish-tan to gray in color with vivid dark bands on the body and tail. As they grow older, their overall coloration becomes more pale and uniform and the dark bands fade. All adult crocodiles have a hump in front of the eye, and tough, asymmetrical armor-like scutes (scale-like plates) on their backs. The American crocodile is distinguished from the American alligator by a relatively narrow, more pointed snout and by an indentation in the upper jaw that leaves the fourth tooth of the lower jaw exposed when the mouth is closed. Moreover, alligators have two nostrils separated by a bony septum covered in skin, while American crocodiles have two nostrils that touch each other in a single depression on the tip of the snout (P. Ross, University of Florida, personal communication 2005). In Florida, the crocodile ranges in total length from 26.0 centimeters (10.3 inches) at hatching to 3.8 meters (12.5 feet [ft]) as adults (Moler 1991a). Larger specimens in Florida were reported in the 1800s (Moler 1991a) and may occur in south Florida currently, and individuals as large as 6 to 7 meters (19.7 to 23.0 ft) have been reported outside the United States (Thorbjarnarson 1989).

Taxonomy

No subspecies are recognized, although geographic variation exists among populations in Florida, Jamaica, and the Pacific coast. Populations in Florida, Jamaica, and the Dominican Republic differ from each other in their gene frequencies (Menzies and Kushlan 1991). Densmore and White (1991) used molecular data to assess phylogenetic relationships within the Crocodylia, including all species in the genus Crocodylus; the closest relative of C. acutus was C. intermedius by one analysis using rDNA, C. moreletii by another analysis that used both rDNA and mtDNA; overall, New World species of Crocodylus appeared to be more closely related to each other than to species in other parts of the world. See Ernst et al. (1999) for further taxonomic discussion. Milián-García et al. (2011) examined microsatellite loci plus DNA sequence data from nuclear (RAG-1) and mitochondrial (cytochrome b and cytochrome oxidase I) genes of Crocodylus acutus and C. rhombifer from Cuba. They found that C. acutus from Cuba is more closely related to C. rhombifer than to C. acutus from Central America. Thus current taxonomy does not appear to be an accurate reflection of evolutionary relationships. The researchers also found evidence of hybridization between the two species in Cuba. Further study is needed before taxonomic issues can be resolved. (Milián-García et al. 2011). (NatureServe, 2015)

Current Range

The present distribution of the American crocodile includes coastal wetlands and rivers of south Florida, Cuba, Jamaica, and Hispaniola (along the Caribbean coast from Venezuela north to the Yucatan peninsula, and along the pacific coast from Sinaloa, Mexico to the Rio Tumbes of Peru [Moler 1992]). Within Florida, the American crocodile historically occurred as far north as Indian River County on the east coast and Tampa Bay on the west coast, and as far south as Key West (DeSola 1935; Hornaday 1914; Kushlan and Mazzotti 1989; Allen and Neill 1952; Neill 1971). The current range of the American crocodile in Florida largely consists of coastal areas of Miami-

Dade, Monroe, Collier, and Lee Counties. Crocodiles are regularly observed in the Everglades National Park (ENP) along the shoreline of Florida Bay, in the Florida Keys (primarily on northern Key Largo, and within the Cooling Canal System (CCS) and adjancent canals and wetlands at the Florida Power and Light (FPL) Turkey Point Nuclear Power Plant. Crocodiles are still known to occur on the west coast of Florida as far north as Sanibel Island. Sightings of crocodiles are also infrequently reported north of Miami-Dade County on the east coast (a crocodile was documented in Indian River County in October 2004)). It was thought that the American crocodile no longer regularly occurred in the Keys south of Key Largo (Jacobsen 1983; P. Moler, Florida Fish and Wildlife Conservation Commission [FWC], personal communication 2002). However, confirmed sightings have been reported with increasing frequency in many of the lower Keys, and we believe that these observations may indicate that crocodiles are expanding their range back into the Keys. A small population of crocodiles (at least 21 individuals) has been observed using wetlands adjacent to the airfield at the Key West Naval Air Station on Stock Island in 2014 (Mazzotti 2014). Moreover, a crocodile was also observed as far south as Fort Jefferson in the Dry Tortugas in May 2002 (O. Bass, ENP, personal communication 2002). The breeding range of the American crocodile in Florida is still restricted relative to its reported historic range (Kushlan and Mazzotti 1989), with most breeding occurring on the mainland shore of Florida Bay between Cape Sable and Key Largo (Mazzotti et al. 2002). Nesting occurs in three primary locations: Key Largo at the Crocodile Lake National Wildlife Refuge, ENP, and the CCS of the FPL's Turkey Point Power Plant. The observed increase in nesting during the last 30 years (see below) is largely due to increased nesting at the Turkey Point Power Plant site (Tucker et al. 2004). Nesting has also been recently documented in the Keys. A crocodile nest has been observed on Lower Matecumbe Key during 2003, 2004, and 2005 (M. Cherkiss, University of Florida, personal communication 2005). In 2015, a nest was located in Virginia Key in northern Biscayne Bay (F. Mazzotti, University of Florida, personal communication 2015).

Critical Habitat Designated

Yes; 9/4/1976.

Legal Description

On September 24, 1976, the U.S. Fish and Wildlife Service designated critical habitat for the American crocodile (Crocodylus acutus) pursuant to Section 7 of the Endangered- Species Act of 1973 (41 FR 41914 - 41916). This Final Rule was corrected and augmented on September 22, 1977 (42 FR 47840 - 47845).

Critical Habitat Designation

The critical habitat designation for Crocodylus acutus includes an area in Florida.

Florida. All land and water within the following boundary: Beginning at the easternmost tip of Turkey Point, Dade County, on the coast of Biscayne Bay; thence southeastward along a straight line to Christmas Point at the southernmost tip of Elliott Key; thence southwestward along a line following the shores of the Atlantic Ocean side of Old Rhodes Key, Palo Alto Key, Angelfish Key, Key Largo, Plantation Key, Windley Key, Upper Matecumbe Key, Lower Matecumbe Key, and Long Key, to the westernmost tip of Long Key; thence northwestward along a straight line to the westernmost tip of Middle Cape: thence northward along the shore of the Gulf of Mexico to the north side of the mouth of Little Sable Creek; thence eastward along a straight line to the northernmost point of Nine-Mile Pond; thence northeastward along a straight line to the point of beginning.

Primary Constituent Elements/Physical or Biological Features

Not specified. The current population is dependent upon the included habitat of Florida Bay and associated brackish marshes, swamps, creeks, and canals.

Special Management Considerations or Protections

All of the areas delineated are considered Critical Habitat because they contain constituent elements necessary to the normal needs or survival of one of the species in question. Specifically for the American Crocodile the delineated area must be considered an absolute minimum amount of Critical Habitat in Florida. The current population of the State, with only 200 to 300 individuals, Is concentrated in this area and is de- pendent upon the included habimt of Florida Bay and associated brackish marshes, swimps. creeks, and canals. All known breeding females, of which there are less than kn in Florida. inhabit anti nest in the delineated area.

Life History

Feeding Narrative

Juvenile: Hatchlings feed largely on small fish but will also eat crabs, snakes, insects, and other invertebrates (Moler 1992).

Adult: American crocodiles are opportunistic feeders and will eat whatever they can catch and consume. Hatchlings feed largely on small fish but will also eat crabs, snakes, insects, and other invertebrates (Moler 1992). Adult crocodiles are capable of taking large prey but generally do not capture prey larger than a raccoon (Procyon lotor) or cormorant (Phalacrocorax auritus). The diet of adult crocodiles consists of snakes, fish, crabs, small mammals, turtles, and birds (Moler 1992). Crocodiles usually forage from immediately prior to sunset to just after sunrise (Lang 1975; Mazzotti 1983).

Reproduction Narrative

Adult: Female crocodiles reach sexual maturity at approximately 10 to 13 years of age (about 2.25 meters total length) (Mazzotti 1983; LeBuff 1957). The size and age that male crocodiles reach sexual maturity is not currently known (Ogden 1978). Courtship and breeding occur in late winter and early spring, and nests are usually built in late April or early May (Moler 1992). Females will only produce one clutch of eggs per year, although it is not known if a female will produce clutches in consecutive years. Nests are constructed on beaches, stream banks, and levees, and many nest sites are used recurrently. Female crocodiles may simply dig a hole at the nest site, but usually construct a nest mound at the nesting site by scraping together soil. If a mound is constructed, a hole is dug in the middle of the nest mound prior to egg laying. Approximately 20 to 50 eggs are deposited in the nest mound or nest hole. The average clutch size is about 35 eggs. Following laying, the female covers up the eggs with soil and the eggs incubate at the nest site for approximately 85 to 90 days (Moler 1992). In Florida, female crocodiles have not been observed to defend their nest during incubation (Kushlan and Mazzotti 1989). However, once the eggs begin hatching, the female usually opens the nest and carries the hatchlings to water in her mouth. Hatchlings are not able to escape the nest cavity without assistance from their mother. Crocodile hatchlings remain together in a loose aggregation for several days to several weeks following hatching. Parental care of young crocodiles has not been observed in Florida, although it has been reported in other parts of the American crocodile's range (Moler 1992).

Habitat Narrative

Adult: The American crocodile in south Florida occurs primarily in mangrove swamps and along low-energy mangrove-lined bays, creeks and inland swamps (Kushlan and Mazzotti 1989). Deep water habitats (>1.0 meter [3.3 ft]) are also known to be an important component of crocodile habitat (Mazzotti 1983). Crocodiles exhibit seasonal differences in habitat use. For example, during the breeding and nesting season, adults outside of Key Largo and Turkey Point can be found along the shoreline of Florida Bay with males located further inland than females (L. Brandt, U.S. Fish and Wildlife Service [Service]and F. Mazzotti, University of Florida, personal communication 1998; P. Moler, FWC, personal communication 1998). During the non-nesting season, crocodiles are usually found further inland in fresh and brackish water swamps, creeks, and bays (Kushlan and Mazzoti 1989). Nesting habitat includes sites with sandy shorelines or raised marl creek banks adjacent to deep water (Service 1999). Crocodiles also nest on berms and other sites where sandy fill has been placed (J. Dixon, personnel communication 2014). Sites optimal for nesting provide appropriate soils for incubation, are generally protected from wind and wave action, and have access to deeper water (Service 1999). Relationships with other species – The American crocodile may co-occur with the American alligator (Alligator mississippiensis) in south Florida. Co-occurrence of these species is most likely during the non-nesting season or when salinities are low. Most crocodilians are known to tolerate the presence of other crocodilian species provided food and other habitat requirements are not limiting (Service 1999). However, little is known concerning the interspecific interactions that occur between crocodiles and alligators. Alligators and crocodiles both occur within the vicinity of the cooling canal system at Turkey Point Power Plant. Anecdotal evidence suggests that crocodiles may aggressively exclude alligators from using a freshwater canal favored by crocodiles known as the Interceptor Ditch (J. Wasilewski and J. Lindsay, FPL, personal communication 2004). Nevertheless, crocodiles and alligators have both been reported to construct nests on the same canal berm located in the vicinity of Marco Island in Collier County, Florida (Service 1999). American crocodiles are most susceptible to predation during incubation and as juveniles. American crocodile eggs are taken primarily by raccoons, although depredation rates of crocodile nests are typically low in south Florida. Hatchlings and subadults are known to be taken by a variety of predators including wading birds, gulls, crabs, sharks, alligators (in areas where they co-occur) and adult crocodiles (Service 1999). Adult crocodiles have no known predators other than humans.

Dispersal/Migration

Motility/Mobility

Adult: Crocodiles may make seasonal movements between freshwater and saline habitats (Gaby et al. 1985).; Nonmigrant: N; Local migrant: Y; Distant migrant: N; (NatureServe, 2015)

Migratory vs Non-migratory vs Seasonal Movements

Adult: Crocodiles may make seasonal movements between freshwater and saline habitats (Gaby et al. 1985).; Nonmigrant: N; Local migrant: Y; Distant migrant: N; (NatureServe, 2015)

Dispersal

Adult: Crocodiles may make seasonal movements between freshwater and saline habitats (Gaby et al. 1985).; Nonmigrant: N; Local migrant: Y; Distant migrant: N; (NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Crocodiles may make seasonal movements between freshwater and saline habitats (Gaby et al. 1985).; Nonmigrant: N; Local migrant: Y; Distant migrant: N; (NatureServe, 2015)

Additional Life History Information

Adult: Crocodiles may make seasonal movements between freshwater and saline habitats (Gaby et al. 1985).; Nonmigrant: N; Local migrant: Y; Distant migrant: N; (NatureServe, 2015)

Population Information and Trends

Population Trends:

Increasing (USFWS, 2022)

Population Size:

698 to 3,150 non-hatchling individuals (USFWS, 2022)

Population Narrative:

The number of American crocodiles that occurred historically in south Florida is difficult to determine because many records are anecdotal and observers may have confused crocodiles with alligators. Moreover, the remoteness and inaccessibility of estuarine habitats to humans made obtaining a reliable estimate of the crocodile population problematic. The population of the American crocodile in south Florida has increased substantially during the last 40 years. The most recent population estimate suggests that the crocodile population contains 1,200 to 2,000 individuals (not including hatchlings) (P. Moler, FWC, personal communication 2005; F. Mazzotti, University of Florida, personal communication 2005). This estimate was derived using American crocodile nesting data and by applying demographic characteristics observed in other crocodilian species (i.e., Nile crocodiles [Crocodylus niloticus] and American alligators) suggesting that breeding females make up 4 to 5 percent of the non-hatchling population and about 75 percent of reproductively mature females breed and nest each year. However, Mazzotti (2015 personal communication) states that based on his recent survey work, he now believes that the crocodile population may now be beginning to decline. The Service will monitor results of crocodile surveys conducted over the next few years closely to determine if a downward trend is occurring. Nest survey data collected in south Florida also suggest that the American crocodile population has increased. Nesting effort has increased from about 20 nests per year in the late 1970s to about 91 to 94 nests in 2005 (S. Klett, Service, personal communication 2005; M. Cherkiss, University of Florida, personal communication 2005; J. Wasilewski, FPL, personal communication 2005). Surveys detect approximately 80 to 90 percent of nests (F. Mazzotti, University of Florida, personal communication 2005; J. Wasilewski, FPL, personal communication 2006) and are generally unable to distinguish those nests that contain more than one clutch of eggs from different females without excavating the nests. In some instances, surveyors are able to determine that more than one female has laid eggs at a communal nest by visiting the nest over a series of days and observing hatching of separate nests (J. Wasilewski, FPL, personal communication 2005b). Communal nests that are not distinguishable result in a possible underestimation of nests and/or females. Crocodile nesting in Florida has increased substantially since the species was listed (11 nests were recorded in 1977 compared with 189 nests in 2021, Figure 7). Approximately 60 to 70 percent of the current total nesting occurs within the Flamingo/Cape Sable area of ENP (e.g., 120 of 189 nests [63.4 percent] in 2021) with the remainder of nesting occurring primarily at northeast Florida Bay, the

TPPP, and Key Largo at the CLNWR. A small number of nests are constructed annually in the other area (Figure 6). Total crocodile nesting in Florida has remained stable or increased since the last review of the crocodile was completed in 2007 (40 FR 44149). For the period from 2007 to 2021 the total number of nests has ranged from a low of 101 in 2018 to a high of 189 in 2021 The Service used an equation devised by Chabrek (1966) that incorporates the total nesting data listed in Figure 7 and information regarding the crocodile population in Kushlan and Mazzotti, (1989b) and Wasilewski and Enloe (2006) to estimate the population size of the American crocodile in Florida from 2013 – 2021 (Table 7; this period encompasses the baseline period of 2013 – 2017 defined in recovery criterion number 1 and the most current nesting data available from 2018 – 2021). Based on this method, the Service estimates the population of the American crocodile in Florida for the baseline period for recovery criterion 1 from 2013 through 2017 as ranging from 898 to 2,517. We further estimate the current population (based on nesting data from 2018 through 2021) as containing 698 to 3,150 non-hatchling individuals. The range of the current population size of the American crocodile in Florida is comparable to and encompasses the population estimate of 1,400 to 2,000 non-hatchling individuals reported in the Service's 2007review of the species (40 FR 44149) but contains a lower minimum estimate and a higher maximum estimate (USFWS, 2022).

Threats and Stressors

Stressor: Habitat deterioration
Exposure:
Response:
Consequence:
Narrative: Modification and destruction of nesting habitat was the primary threat to the American crocodile during the 20th century. Nesting habitats that were formerly occupied (e.g., Lake Worth, Palm Beach County, central Biscayne Bay, middle and lower Keys etc.) were destroyed or degraded due to urbanization, and the crocodile has been largely extirpated from many of these areas (DeSola 1935; Service 1984). Although, observations of crocodile nesting at Chapman Field Park (J. Maquire, personal communication 1998) indicate that crocodiles may be reoccupying portions of their former range in central Biscayne Bay. However, continued habitat loss and degradation reduces the likelihood that crocodiles will be able to persist in these areas.

Stressor: Human disturbance
Exposure:
Response:
Consequence:
Narrative: Disturbance due to human encroachment into crocodile habitat may alter normal behavioral patterns of crocodiles. Observations suggest that repeated human disturbances of crocodiles may cause females to abandoned nests or relocate nest sites (Kushlan and Mazzotti 1989). The rising demand for recreational opportunities (e.g., camping, boating, and fishing) is expected to bring more people into contact with crocodiles. Pressure on Federal and State agencies to provide more recreational opportunities on public lands that provide habitat for crocodiles is also expected to increase. An increase in human disturbance due to recreational activities could adversely affect the crocodile.

Stressor: Vehicular mortality
Exposure:

Response:
Consequence:
Narrative: Crocodile mortality due to collisions with vehicles has been an ongoing problem along U.S. Highway 1 and Card Sound Road in Miami-Dade and Monroe Counties (Service 1999). This problem has been particularly acute within the segment of U.S. Highway 1 from Florida City to Key Largo. Wetlands providing habitat for crocodiles are located on both sides of the roadway. However, the only structures that allowed movement of crocodiles under the roadway were three small culverts that are usually submerged. Consequently, approximately three to four crocodiles per year were killed while attempting to cross the roadway (Mazzotti 1983; Moler 1991a). The Florida Department of Transportation reduced vehicle-related crocodile mortality along this section of U.S. Highway 1 by installing a series of wildlife underpasses consisting of large culverts, bridges, and associated fencing. The locations for these structures were determined from discussions with the Service and the FWC and were installed as part of roadway improvements constructed along U.S. Highway 1 from the C-111 Canal to the Lake Surprise Bridge.

Stressor: Climate events
Exposure:
Response:
Consequence:
Narrative: Natural climatic events also have the potential to affect the American crocodile. For example, tropical storms and hurricanes affecting south Florida can result in high winds, large waves, and tidal surges that could result in either direct mortality of adults, and/or the loss of nests, nesting habitat, and other important habitat features (Service 1999). Ogden (1978) suggested hurricanes occurring at regular intervals may serve to regulate the American crocodile population in Florida. South Florida infrequently experiences cold fronts where ambient temperatures drop below 0°C. Such temperatures are likely lethal to crocodiles, although the effects of subfreezing temperature are not well known because crocodiles killed during freezes are rarely found (Dimock 1915; Barbour 1923; Mazzotti 1983). Moler (1991b) suggested that a decline in crocodile nesting effort observed in 1989 may be the result of adult mortality due to a hard freeze that occurred during the previous winter. In 2010, more than 200 crocodiles were estimated to have died from an extreme cold spell that affected south Florida. Drought may also adversely affect crocodiles. Mazzotti and Dunson (1984) suggest that hatchling crocodiles are susceptible to osmotic stress and require access to low salinity water. The freshwater needs of hatchlings are usually met by rainfall depositing a lens of freshwater on the water surface of estuarine environments that may last for days. Hatchlings are likely stressed and occasionally die during periods of low rainfall.

Recovery

Delisting Criteria:
Draft delisting criteria: The American crocodile will be considered for delisting when: 1. At least three of the five nesting areas defined below exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. a) FPL's Turkey Point Power Plant Site b) North Key Largo including the Crocodile Lake National Wildlife Refuge c) Northeast Florida Bay in Everglades National Park (ENP) d) Flamingo/Cape Sable in ENP e) Other (nesting occurring North of the Turkey Point Power Plant Site, Florida Keys South of North Key Largo, and the West Coast of Florida from North of Highland Beach to Sanibel Island). 2. Threats have been addressed

and/or managed to the extent that the species will remain viable into the foreseeable future. (Factor A-E) 3. When, in addition to the above criteria, it can be demonstrated that despite sea level rise and other environmental influences, sufficient suitable habitat remains for the American crocodile to remain viable for the foreseeable future. (Factor A and E) (USFWS, 2019).

Draft additional recovery actions: The following recovery actions are recommended in addition to those listed in the most current recovery plan for the American crocodile: 1. Monitor the effects of climate change and sea-level rise on American crocodile habitat in South Florida. 2. Continue to monitor and control exotic animals that may prey on American crocodiles or their eggs throughout its range (USFWS, 2019).

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES • Maintain nesting sites and create new nesting sites where possible thorough the addition of sand or other materials suitable as nesting substrate. • Continue annual monitoring of crocodile nesting and establish monitoring in currently potential nesting areas that are not surveyed. • Continue to implement projects associated with Comprehensive Everglades Restoration Program or other measures as needed to reduce salinity of waters in adjacent to Florida Bay to improve conditions for crocodiles. • Continue education efforts to increase public awareness of the conservation and habitat needs of the crocodile. • Promote safe passage of crocodiles under roads through installation of culverts and barrier fencing as needed. • Develop a data management system to collate and store American crocodile data (e.g., nesting data) from all sources in a consistent manner (USFWS, 2022).

References

USFWS 2016. Status of the Species and Critical Habitat: Crocodylus acutus (American crocodile). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia.

USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/ecp0/. Accessed April 2016.

U.S. Fish and Wildlife Service. 1976. Endangered and Threatened Wildlife and Plants

Determination of Critical Habitat for American Crocodile, California Condor, Indiana Bat, and Florida Manatee. Final Rule. 41 FR 41914 - 41916 (September 24, 1976)

U.S. Fish and Wildlife Service. 1977. Endangered and Threatened Wildlife and Plants

Correction and Augmentation of Published Rulemaking. Final rule. 42 FR 47840 - 47845 (September 22, 1977).

U.S. Fish and Wildlife Service. 1977. Correction and augmentation of Published Rulemaking. Final Rule. 42 FR 47840 - 47845 (September 22, 1977).

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A. USFWS. 2022. American crocodile (Crocodylus acutus) 5-Year Status Review: Summary and Evaluation. South Atlantic–Gulf and Mississippi Basin Regions. Florida Ecological Services Office. Vero Beach, Florida. 35 pp.

USFWS 2016. Status of the Species and Critical Habitat: Crocodylus acutus (American crocodile). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016. USFWS. 2022. American crocodile (Crocodylus acutus) 5-Year Status Review: Summary and Evaluation. South Atlantic–Gulf and Mississippi Basin Regions. Florida Ecological Services Office. Vero Beach, Florida. 35 pp.

U.S. Fish and Wildlife Service. 2019. Draft Amendment 1 to the Recovery Plan for American Crocodile (Crocodylus acutus).

USFWS. 2022. American crocodile (Crocodylus acutus) 5-Year Status Review: Summary and Evaluation. South Atlantic–Gulf and Mississippi Basin Regions. Florida Ecological Services Office. Vero Beach, Florida. 35 pp.

SPECIES ACCOUNT: *Crotalus willardi obscurus* (New Mexican ridge-nosed rattlesnake)

Species Taxonomic and Listing Information

Listing Status: Threatened; August 4, 1978 (50 FR 34476).

Physical Description

The New Mexico ridge-nosed rattlesnake is 30 to 61 centimeters (12 to 24 inches) long, grayish-brown, and has a distinct ridge on the end of its snout. The upper surface of the snake has irregularly spaced white cross bars, edged with brown in a dull pattern (USFWS 2002). The underside is cream to white, with occasional mottling of grayish to reddish brown. Young have dark gray/black or light yellow tails.

Taxonomy

The New Mexico ridge-nosed rattlesnake was first identified by Frank C. Willard. The validity of C. w. obscurus as a subspecies distinct from C. w. silus is questioned by some herpetologists; however, the New Mexico Department of Game and Fish and the U.S. Fish and Wildlife Service recognize the taxon and state that the scientific name should be used for New Mexico ridge-nosed rattlesnake populations in the Animas and Sierra San Luis until a definitive taxonomic study of the validity of the subspecies is published. All ridge-nosed rattlesnakes are distinguished by the tip of the snout and the anterior canthus rostrals raised into a sharp inernasal ridge. The rostral and mental are absent of white vertical line, and a white flash-mark is absent in the New Mexico ridge-nosed rattlesnake (USFWS 1985).

Historical Range

The New Mexico ridge-nosed rattlesnake occurs in the Animas Mountains of southwestern New Mexico; Peloncillo Mountains in southwestern Arizona; and throughout Sierra de San Luis in Chihuahua, Mexico. This species also likely occurs in the Sonora portion of the Sierra de San Luis (NatureServe 2015; USFWS 1985).

Current Range

The New Mexico ridge-nosed rattlesnake is rare and uncommon throughout its historical range (NatureServe 2015; USFWS 1985).

Distinct Population Segments Defined

No

Critical Habitat Designated

Yes; 8/4/1978.

Legal Description

On August 4, 1978, the U.S. Fish and Wildlife Service designated critical habitat for Crotalus willardi obscurus under the Endangered Species Act of 1973, as amended (43 FR 34476 - 34480).

Critical Habitat Designation

Critical habitat for the New Mexican ridge-nosed rattlesnake is designated in New Mexico: Hidalgo County, at elevations between 6.200 feet and 8,532 feet in Bear, Indian, and Spring Canyons, Animas Mountains.

Primary Constituent Elements/Physical or Biological Features

Not specified: "With respect to the New Mexican ridge-nosed rattlesnake, the areas determined as critical habitat satisfy all known criteria for the evolutionary, ecological, behavioral, and physiological requirements of the species. Dens are available which provide winter and summer retreats. Vegetation provides cover, and lizards and rodents are abundant in the area and provide an adequate source of food items."

Special Management Considerations or Protections

Not available

Life History

Feeding Narrative

Adult: The New Mexico ridge-nosed rattlesnake is a venomous carnivore and inverivor that is an opportunistic hunter and scavenger, and forages more actively than other rattlesnake species that depend more on an ambush strategy. The New Mexico ridge-nosed rattlesnake has a widely distributed food resource distribution; it primarily eats lizards and secondarily eats scorpions, centipedes, small mammals, birds, and carrion. The New Mexico ridge-nosed rattlesnake is diurnal and hibernates. This snake is inactive in cold temperatures and extreme heat; the period of time when the snake is most active is during daylight hours from July through September (NatureServe 2015; USFWS 1985; USFWS 2002).

Reproduction Narrative

Adult: Mating and copulation has been reported to occur in the wild from June through October (Holycross and Goldberg 2001). Male New Mexico ridge-nosed rattlesnakes appear to be capable of inseminating females from June through September and females likely have a biennial or longer reproductive cycle. The female reproductive cycle likely includes yolk deposition in one or more reproductive seasons, followed by a season with ovulation, development of young, and parturition. New Mexico ridge-nosed rattlesnakes are live-bearers, and young rattlesnakes are born fully formed from late July through August (Holycross and Goldberg 2001) and may be coincident with occurrence and emergence of certain prey items suitable for baby snakes (see Diet below). Litter size is related to the size and age of the female, where small females have smaller litter size and large females have larger litter size. Female size is influenced by the age and health of the individual, as well as available resources. Holycross and Goldberg (2001) report that the average litter size for twelve New Mexico ridge-nosed rattlesnakes was 5.5 and ranged between 4-8; similar litter sizes were reported for the three subspecies of ridge-nosed rattlesnakes (n=25) assessed averaging 5.4 with a range of 2-9. Because the New Mexico ridgenosed rattlesnake generally has a low reproductive output that is coupled with some loss of neonatal or juvenile snakes, and a single male can sire multiple females, population persistence or recovery may be largely dependent on adult female survivorship. (USFWS, 2019)

Geographic or Habitat Restraints or Barriers

Adult: Habitat destruction has reduced New Mexico ridge-nosed rattlesnake habitat (USFWS 1985).

Spatial Arrangements of the Population

Adult: Clumped according to resources.

Environmental Specificity

Adult: Broad/generalist or community with all key requirements common.

Tolerance Ranges/Thresholds

Adult: Moderate

Site Fidelity

Adult: Moderate

Habitat Narrative

Adult: The New Mexico ridge-nosed rattlesnake is a montane subspecies that can be found in pine-oak woodlands, on steep, rocky hillsides, in canyon bottoms, and on talus slopes at elevations ranging from approximately 5,971 to 8,500 feet (ft) (1,820 meters (m) to 2,590 m) in the Animas Mountains and 4,987 ft to 6,200 ft (1,520 to 1890 m) in the Peloncillo Mountains (NMDGF 1990; Degenhardt et al. 1996; Fedorko 2017). Holycross (1995) reported habitat use in the Animas Mountains on steep east and southeast facing slopes, dominated by bunchgrass and beargrass, with widely spaced oaks and junipers or on steep east and southeast facing slopes with New Mexico locust and talus. Rocky areas or talus with spaces may be an important habitat component. (USFWS, 2019)

Dispersal/Migration

Motility/Mobility

Adult: Moderate

Migratory vs Non-migratory vs Seasonal Movements

Adult: Nonmigratory

Dispersal

Adult: Moderate

Immigration/Emigration

Adult: No

Dependency on Other Individuals or Species for Dispersal

Adult: No

Dispersal/Migration Narrative

Adult: Rattlesnakes are active on the surface as early as April and as late as October, with heightened activity between July and September. Temperature and rainfall (summer monsoons) are important factors in activity levels. This species moves only relatively short distances, and moves less frequently compared to other rattlesnake species. This sedentary nature contributes to the limited area the species is known to occupy. The New Mexico round-nosed rattlesnake has a moderate rate of mobility. These snakes do not immigrate or emigrate, are nonmigratory, and have a moderate dispersal rate (NatureServe 2015; USFWS 1985).

Additional Life History Information

Adult: Rattlesnakes are active on the surface as early as April and as late as October, with heightened activity between July and September. Temperature and rainfall (summer monsoons) are important factors in activity levels. This species moves only relatively short distances, and moves less frequently compared to other rattlesnake species. This sedentary nature contributes to the limited area the species is known to occupy (ECOS 2015).

Population Information and Trends

Population Trends:

Unknown short-term trend, declining long-term trend (NatureServe 2015).

Number of Populations:

3 (USFWS, 2019)

Population Size:

The United States population for New Mexico ridge-nosed rattle snakes was estimated at 500 snakes in the 1960s, and it is thought that collecting may have further reduced the population by one-fourth (NatureServe 2015).

Resistance to Disease:

Moderate; a variety of disease and pathogenic organisms from which they suffer have been an integral part of the evolution of the New Mexico ridge-nose population, but these are currently poorly understood (USFWS 1985).

Adaptability:

Low

Population Narrative:

The population of the New Mexico ridge-nosed rattlesnake is thought to comprise around 375 individuals in the United States. The last population estimate, made in the 1960s, was 500 snakes; it is thought that collection of snakes has reduced the populations by one-fourth. All New Mexico round-nose rattlesnakes are considered grouped into one population. The short-term population trend is unknown, but the long-term population trend is one of a species in decline. A variety of disease and pathogenic organisms from which they suffer have been an integral part of the evolution of the New Mexico ridge-nose population, but these are currently poorly understood (NatureServe 2015; USFWS 1985; USFWS 2002). There are currently 3 known isolated populations of the New Mexico ridge-nosed rattlesnake subspecies: Animas Mountains (NM), Peloncillo Mountains (NM and AZ), and the Sierra San Luis Mountains (Mexico). (USFWS, 2019) Holycross and Douglas (2007) estimated an instantaneous (yearly) abundance that did not exceed 151 (±26) individuals at their West Fork Canyon study site in the Animas Mountains. Davis (2008) estimated an instantaneous population of 304.7 (± 57.6) for the entire Animas Mountains population, and suggest that the Animas Mountains population is the largest of the three extant populations, and represents approximately half of the estimated individuals across the distribution of the New Mexico ridge-nosed rattlesnake. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat disturbance
Exposure: New Mexico ridge-nosed rattlesnake habitat is destroyed.
Response: See narrative.
Consequence: Reduction in population numbers, reduction of suitable habitat.
Narrative: Habitat disturbance, both past and present, such as from fires and excessive cattle grazing, have affected the habitat for the New Mexico ridge-nosed rattlesnake. In addition, new habitat stressors of concern include mining, which has been explored in some of the New Mexico ridge-nosed rattlesnake habitats for many years. Habitat destruction is also linked with the use of dynamite to blast boulders and gain access to snakes for collection (explained below). The effect of habitat disturbance, combined with snake collecting, has been especially detrimental to the New Mexico ridge-nosed rattlesnake (USFWS 1985).

Stressor: Collecting
Exposure: New Mexico ridge-nosed rattlesnake is collected.
Response: Mortality, taken out of the wild.
Consequence: Reduction in population numbers.
Narrative: The effects of collecting the New Mexico ridge-nose rattlesnake in the Naimas Mountains between 1957 and 1974 are unknown, because there are no estimates of the abundance of these snakes prior to collecting. However, collecting is thought to have negatively harmed the population, with lower numbers that can still be seen today. The physical attractiveness of this species, combined with its limited geographic range, has made it a very desirable snake for scientific and commercial purposes. Snakes could be priced higher than $175, depending on the size (USFWS 1985).

Stressor: Natural threats and stressors
Exposure: See narrative.
Response: See narrative.
Consequence: See narrative.
Narrative: Natural threats have had an unknown effect on New Mexico ridge-nosed rattlesnake populations. Natural threats include predation, starvation, and disease, all of which are potential factors that can harm the New Mexico ridge-nosed rattlesnake populations (USFWS 1985).

Recovery

Reclassification Criteria:
Even though the very restricted range of Crotalus willardi obscurus as it is presently known may preclude eventual delisting, reclassification to nonthreatened status, nonetheless, could be considered when:

All important areas of New Mexico ridge-nosed rattlesnake habitat in Mexico and New Mexico are identified.

Habitat in New Mexico is protected from adverse modification.

The continued existence of the taxon in its habitat is assured.

Delisting Criteria:
Need to develop delisting criteria.

Recovery Actions:

- Protect ridge-nose rattlesnakes and their habitat.
- Investigate status and biology of ridge-nose rattlesnakes.
- Clarify the taxonomic status of ridge-nose rattlesnake populations in the Animas Mountains and Sierra San Luis.
- Establish two or three captive populations.
- Disseminate information about New Mexico ridge-nose rattlesnakes.
-

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS We recommend the following future actions for the New Mexico ridge-nosed rattlesnake: 1. Federal and state agencies, researchers, and other stakeholders should work together to consolidate data and information to analyze, assess, and inform our understanding of the status of the subspecies and to develop future management, conservation, and recovery actions. 2. Use all available information and data to complete a Species Status Assessment. 3. Update the Recovery Plan for the New Mexico ridge-nosed rattlesnake. Recovery strategies should address major threats, including a strategy for conservation and recovery given climate change driven impacts to habitat; illegal collection assessment and strategies; and strategies for managing small, isolated populations. 4. Assess the need for genetic management; if warranted, develop a Genetic Management Plan. 5. Gain an understanding of fire ecology of the area and how altered fire regimes and wildfire may affect the subspecies in the short- and long-term. 6. Work with states, Law Enforcement, and U.S. Customs and Border Protection to provide training on species identification and awareness of potential illegal collection and avoidance of hitting snakes on roads. 7. Develop and fund research in the Peloncillo Mountains to identify the distribution and threats specific to the Peloncillo population. 8. Encourage law enforcement agencies to commit to significantly elevating signage, patrols, vehicle stop and searches, and campsite interviews along the Geronimo Trail and other forest roads in the Peloncillo Mountains to increase the visibility of wildlife law enforcement and discourage the potential for illegal collection of New Mexico ridgenosed rattlesnake within its only publically-accessible, and most well-known, population. 9. Coordinate with Mexican partners to better understand the status, threats, and conservation of the subspecies in Mexico. (USFWS, 2019)

Additional Threshold Information:

-
-

References

50 FR 34476-80. Listing of the New Mexican Ridge-Nosed Rattlesnake as Threatened Species with Critical Habitat, Final Rule. Vol. 42, No 151. Federal Register 34476-80. August 4, 1978. Available online at: http://ecos.fws.gov/docs/federal_register/fr232.pdf

NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Crotalus willardi obscurus. Available online at: http://explorer.natureserve.org/servlet/NatureServe?searchName=Crotalus+willardi+obscurus. Date accessed: September 21, 2015

USFWS (U.S. Fish and Wildlife Service). 1985. New Mexico Ridge Snake Recovery Plan. U.S. Fish and Wildlife Services, New Mexico. Available online at: http://ecos.fws.gov/docs/recovery_plan/850322.pdf. Date accessed: September 21, 2015

USFWS (U.S. Fish and Wildlife Service). 2002. General Species Information. Arizona Ecological Services Field Office. Available online at: http://www.fws.gov/southwest/es/arizona/NewMexico.htm. Date accessed: September 21, 2015.

U.S. Fish and Wildlife Service. 1978. Listing of the New Mexican Ridge-Nosed Rottlesnoke as a Threatened Species With Critical Habitat. Final rule. 43 FR 34476 - 34480 (August 4, 1978).

ECOS (Environmental Conservation Online System). 2015. Crotalus willardi obscurus (New Mexico ridge-nosed rattlesnake). Available online at: http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=C01S. Date accessed: October 20, 2015

USFWS (U.S. Fish and Wildlife Service). 2002. General Species Information. Arizona Ecological Services Field Office. Available online at: http://www.fws.gov/southwest/es/arizona/NewMexico.htm. Date accessed: September 21, 2015.
USFWS. 2019. New Mexico Ridge-nosed Rattlesnake (Crotalus willardi obscurus) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service New Mexico Ecological Services Field Office Albuquerque, NM. 23 pp.

USFWS. (U.S. Fish and Wildlife Service). 1985. New Mexico Ridge Snake Recovery Plan. U.S. Fish and Wildlife Services, New Mexico. Available online at: http://ecos.fws.gov/docs/recovery_plan/850322.pdf. Date accessed: September 21, 2015.

USFWS (U.S. Fish and Wildlife Service). 1985. New Mexico Ridge Snake Recovery Plan. U.S. Fish and Wildlife Services, New Mexico. Available online at: http://ecos.fws.gov/docs/recovery_plan/850322.pdf. Date accessed: September 21, 2015.

USFWS. 2019. New Mexico Ridge-nosed Rattlesnake (Crotalus willardi obscurus) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service New Mexico Ecological Services Field Office Albuquerque, NM. 23 pp.

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

Yes;

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 potenital populations (USFWS, 2019b)

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)

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)

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)

References

NatureServe Explorer (2015): An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://explorer.natureserve.org. (Accessed: March 29, 2016)

U.S. Fish and Wildlife Service. 2008. Eastern Indigo Snake Drymarchon couperi 5-Year Review Summary and Evaluation U.S. Fish and WIldlife Service Southeast Region Mississippi Ecological Services Field Office Jackson, Mississippi

NatureServe Explorer (2015): An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://explorer.natureserve.org. (Accessed: March 29, 2016).

USFWS. 2019. Species status assessment report for the eastern indigo snake (Drymarchon couperi). Version 1.1, July, 2019. Atlanta, Georgia. USFWS. 2019b. Eastern Indigo Snake Drymarchon corais couperi 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Southeast Region Georgia Ecological Services Field Office Athens, Georgia. 51 pp.

U.S. Fish and Wildlife Service. 1982. Eastern Indigo Snake Recovery Plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 23 pp

USFWS. 2019b. Eastern Indigo Snake Drymarchon corais couperi 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Southeast Region Georgia Ecological Services Field Office Athens, Georgia. 51 pp.

U.S. Fish and Wildlife Service. 2019. Draft Eastern Indigo Snake Recovery Implementation Strategy. Atlanta, Georgia. 37 pp.

USFWS. 2019. Species Status Assessment (SSA) Report for the Eastern Indigo Snake (Drymarchon couperi). Version 1.1. July 8, 2019. U.S. Fish and Wildlife Service Southeast Region Atlanta, GA. 160 pp.

USFWS. 2019. Species status assessment report for the eastern indigo snake (Drymarchon couperi). Version 1.1, July, 2019. Atlanta, Georgia.

SPECIES ACCOUNT: *Emoia slevini* (Slevin's skink)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

Slevin's skink measures 3 in (77 mm) from snout to cloaca vent (the opening for reproductive and excretory ducts), although length can vary slightly (Vogt and Williams 2004, p. 65). Fossil remains indicate its prehistoric size was much larger, up to 4.3 in (110 mm) in length (Rodda 2010, p. 3). Slevin's skink is darkly colored, from olive to brown, with darker flecks in a checkerboard pattern, and a light orange to bright yellow underside (Vogt and Williams 2004, p. 65). Their skin tends to be shiny, and is very durable and tough. Juveniles may appear cream-colored (Vogt and Williams 2004, p. 65; Rodda 2010, p. 3) (USFWS, 2014).

Taxonomy

Slevin's skink (Emoia slevini, guali'ek halom tano) is a small lizard in the reptile family Scincidae, the largest lizard family in number of worldwide species. Slevin's skink was first described in 1972 by Walter C. Brown and Marjorie V.C. Falanruw, which is the most recent and accepted taxonomy (Brown and Falanruw 1972, p. 107) (USFWS, 2014).

Historical Range

See current range/distribution.

Current Range

Slevin's skink previously occurred on the southern Mariana Islands (Guam, Cocos Island, Rota, Tinian, and Aguiguan), where it is now extirpated, except from Cocos Island off of Guam, where it was recently rediscovered (Fritts and Rodda 1993, p. 2; Steadman 1999; Lardner 2013, in litt.) (USFWS, 2014). Distribution: Cocos Island, Sarigan, Guguan, Pagan, Alamagan, Asuncion, Guam, Rota, Tinian and Aguiguan (USFWS, 2020b).

Critical Habitat Designated

Yes;

Life History

Reproduction Narrative

Adult: The females carry their eggs internally and give birth to live young (Brown 1991, pp. 14–15). Other specific life-history or habitat requirements of Slevin's skink are not well documented (Rodda 2002, p. 3) (USFWS, 2014).

Habitat Narrative

Adult: Based on both older and more recent observations, the species occurs in the forest ecosystem, with most individuals observed on the forest floor using leaf litter as cover (Brown and Falanruw 1972, p. 110; GDAWR 2006, p. 107; Cruz et al. 2000, p. 21; Lardner 2013, in litt.). Occasionally, individuals were observed in low hollows of tree trunks (Brown and Falanruw 1972, p. 110) (USFWS, 2014).

Dispersal/Migration

Population Information and Trends

Population Trends:

Decreasing (USFWS, 2014)

Number of Populations:

9 (USFWS, 2020b)

Population Size:

Unknown (USFWS, 2020b)

Population Narrative:

Once widespread, the remaining known populations of Slevin's skink are made up of a few individuals on Cocos Island, and occurrences of undetermined numbers of individuals on Alamagan and Sarigan. Populations of Slevin's skink are decreasing from initial numbers observed on Cocos Island, Alamagan, Pagan, and Asuncion, and it has not been reobserved on Guam, Rota, Tinian, and Aguiguan; the species has been lost from 90 percent of its former range (USFWS, 2014). Slevin's skink was historically found on 9 islands across the Marianas and it is currently known from four islands with a potential population from a fifth island, including one island where it was not known historically. There are currently an unknown number of individuals, but trends show declining numbers of Emoia slevini, and no representation in ex situ breeding. Surveys are ongoing and there is some protection from habitat degradation through exclusion fencing for ungulates and research on brown tree snake control (USFWS, 2020)

Threats and Stressors

Stressor: Agriculture and urban development (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Agriculture and urban development are listed as threats to this species (USFWS, 2014).

Stressor: Nonnative plants (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Nonnative plants are listed as a threat to this species habitat (USFWS, 2014).

Stressor: Typhoons (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Typhoons are listed as a threat to this species habitat (USFWS, 2014).

Stressor: Predation (USFWS, 2014)

Exposure:
Response:
Consequence: Loss of individuals
Narrative: Predation by rats, brown tree snakes and monitor lizards are listed as a threat to this species (USFWS, 2014).

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Recovery

Recovery Actions:

- A recovery plan has not been completed for this species.
- Threat and Recovery Potential: Full species with a moderate degree of threat and a high recovery potential. (USFWS, 2020b)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • Surveys and inventories—Continue to assess the status of known occurrences of Emoia slevini in historical locations and potentially suitable habitat including island-wide surveys throughout the historical range. • The future of the expanded training should be revisited at the next five year review. • Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect individuals from the negative impacts of feral ungulates. • Predation by rodents—Implement effective control methods for rats in all populations. • Predation by brown tree snakes—Implement effective control methods for brown tree snakes to prevent the spread to other islands. • Predation and competition by other lizards—Implement effective control methods for monitor lizards and, if possible, the curious skink at all populations. • Captive propagation for genetic storage and reintroduction—Attempt to establish a captive breeding population for maintenance of genetic stock, and for use in translocation and reintroduction. Conduct genetic testing to establish the "genetic barcode" for the species, and ensure the best practices in husbandry, captive rearing, and genetic diversity measures. • Climate change adaptation strategy—Research suitability of habitat in the future due to the impacts of climate change. • Alliance and partnership development—Continue to contribute to planning and implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2020)
- Current Management Actions: • Irregular monitoring occurs on Cocos Island and some Northern Mariana Islands, including Alamagan and Guguan (Liske-Clack et al. 2016, pp. 31, 33; Murray et al. 2018, pp.3032; Mathies pers comm. 2019) • Biosecurity efforts to keep brown tree snakes from spreading to other islands (U.S. Navy 2015, entire; Perry and Vice 2009, p. 998; BTSWG 2016, pp 1 5-6) • A 2020 Memorandum of Understanding between Joint Region Marianas (JRM) and the U.S. Fish and Wildlife Service (FWS) outlined a mutual understanding regarding the intentions and future considerations of a Department of Defense Readiness and Environmental Protection Integration Initiative to address conservation of upland vegetation communities for the Emoia slevini as well as other federally listed species on Guam. • Feral ungulates were removed from Sarigan in 1998 completely removed by 2000. The vegetation has been documented to increase and along with it the numbers of skink (Kessler 2002). While not in the last five year this action has made a positive

impact on the species and could prove to be a useful model in the future. • The eradication of rats from Cocos Island in 2010 has increased the viability of the species. They were on the island at below detectable levels until a year after the removal of the rats to benefit the reintroduction of the Koko (Guam rail). (USFWS, 2020)

References

U.S. Fish and Wildlife Service. 2014. Endangered and Threatened Wildlife and Plants

Proposed Endangered Status for 21 Species and Proposed Threatened Status for 2 Species in Guam and the Commonwealth of the Northern Mariana Islands

Proposed Rule. FR Vol. 79, No. 190. Pages 59364-59413. USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/ecp0/. Accessed August 2016. USFWS. 2020b. Recovery outline for 23 Mariana Island Species. Portland, Oregon. 22 pp. + appendices.

Proposed Rule. FR Vol. 79, No. 190. Pages 59364-59413. USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/ecp0/. Accessed August 2016.

Proposed Rule. FR Vol. 79, No. 190. Pages 59364-59413. USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/ecp0/. Accessed August 2016. USFWS. 2020. Slevin’s skink, gualiik halumtanu (Emoia slevini). 5-Year Review Summary and Evaluation. U.S. Fish and Wildlife Service. Pacific Islands Fish and Wildlife Office Honolulu, Hawaii. 18 pp. USFWS. 2020b. Recovery outline for 23 Mariana Island Species. Portland, Oregon. 22 pp. + appendices.

USFWS. 2020b. Recovery outline for 23 Mariana Island Species. Portland, Oregon. 22 pp. + appendices.

USFWS. 2020. Slevin’s skink, gualiik halumtanu (Emoia slevini). 5-Year Review Summary and Evaluation. U.S. Fish and Wildlife Service. Pacific Islands Fish and Wildlife Office Honolulu, Hawaii. 18 pp.

SPECIES ACCOUNT: *Epicrates (=Chilabothrus) inornatus* (Puerto Rican boa (=Chilabothrus))

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 10/13/1970

Physical Description

The color is somewhat variable but usually ranges from pale to dark brown, sometimes grayish, with 70 to 80 darker colored blotches along the back from neck to vent. These dorsal blotches are generally dark-bordered with the centers of a lighter hue. Maximum size is approximately 6 and a half feet (USFWS, 2015).

Taxonomy

The species was first described by Reinhardt (1843) as Boa Inornata and subsequently re-assigned to the neotrpoical genus Epicrates (Boulenger, 1893). This species is believed to be an early derivative of the ancestral continental stock that resembled E. angulifer of Cuba and gave rise to both E. inornatus and E. subflavus of Jamiaca (Sheplan & Shwartz, 1974) (USFWS, 1986).

Historical Range

Schwartz & Thomas (1975) give the distribution of E. inornatus as Puerto Rico, where it is endemic. It is not known from the small islands of Puerto Rico (USFWS, 1986).

Current Range

The PR boa has a widespread distribution and is more common in the karst region of the north-northwest portion of the Island (USFWS, 2011).

Distinct Population Segments Defined

No

Critical Habitat Designated

Yes;

Life History

Feeding Narrative

Adult: In general, movement of boas during a fix was observed significantly more often at night than during daylight hours (USFWS, 2011). In captivity, E. inornatus eats birds, mice, rats and lizards which are killed by constriction and swallowed head first. Rodriguez & Reagan (1984) describe and incident of bat predation in a cave entrance. Boas suspend their bodies from overhanging branches and seize bats as they emerge at dusk (USFWS, 1986).

Reproduction Narrative

Adult: Gravid females of the PR boa are known to use exposed terrestrial debris piles for thermoregulation (Tolson and Henderson 1993), which may contribute to greater use of ground sites by females. A 153-176 gestation period (Huff 1978) supports the observations of Grant (1932) and Reagan (1984) on the birth of young boas during September-October and a mating period between April-May (USFWS, 2011). E. inornatus is ovoviparous. Rivero (1978) reported two gravid females containing 32 and 17 embryos and Perez-Rivera & Velez (1978) reported two other females giving birth to 23 and 26 young. Captive-bred individuals breed annually or biennially; age at first reproduction is between six and seven years; mates on branches (USFWS, 1986).

Geographic or Habitat Restraints or Barriers

Adult: Occurs < 1,000 m elevation (USFWS, 2011)

Environmental Specificity

Adult: Broad (inferred from USFWS, 2011)

Site Fidelity

Adult: Low (USFWS, 2011)

Habitat Narrative

Adult: The PR boa appears to be widely distributed throughout Puerto Rico and utilizes a wide variety of habitats, ranging from mature forest to plantations and disturbed areas. According to the status survey of the PR boa conducted by Bird-Picó (1994), the species has a wide distribution in a variety of habitats including wooded areas, open pastures, shrubs, and cave entrances and interiors. Vines are important for gaining access to trees from either the ground or from other trees or shrubs and provide dense cover for foraging and resting (Wunderle et al. 2004). Tree cavities may be used by boas for resting or prey location. Gould et al. (2008) stated that the PR boa predicted habitat model includes the following land cover types: moist and wet forest, woodland and shrubland mangrove, Pterocarpus, mature dry forest, and dry forest near water bodies, at or below 1,000 m of elevation. Fidelity to a specific site was usually low, as boas only revisited a small percentage of the sites in the home range during the approximate one year each boa was studied. Besides rocks and trees in forested areas, light gaps provided by forest openings and forest edge situations are frequently used for basking by boas (Reagan 1984). The species has also been reported to be very common along streams on tree branches (Schwartz and Henderson 1991) (USFWS, 2011). The habitat types range from wet montane to subtropical dry forest (Rivero, 1978) (USFWS, 1986).

Dispersal/Migration

Motility/Mobility

Adult: Moderate (inferred from USFWS, 2011)

Migratory vs Non-migratory vs Seasonal Movements

Adult: Non-migratory (inferred from USFWS, 2011)

Dispersal

Adult: Low to moderate (inferred from USFWS, 2011)

Dispersal/Migration Narrative

Adult: Home range areas varied from 138.9 m2 (1,495 ft2) to 18,380 m 2 (197,840.7 ft2). Monitored boas moved an average of 12.9 m (42.3ft) daily between fixes (fix= telemetry relocation). Wunderle et al. (2004) also provided detailed information on immobility in addition to daily and monthly movements of boas. According to their findings, boas moved an average of 26.4 m (86.6 ft) daily per move. However, most of the time boas were immobile as evidenced in a mean of 10.2 consecutive days without movement between fixes (USFWS, 2011).

Population Information and Trends

Population Trends:
Declining (USFWS, 1986)

Species Trends:
Stable (USFWS, 2011)

Population Size:
37,903 to 189,515 boas (USFWS, 2021a)

Population Narrative:
The species status is stable; although current population estimates are not available, based on the information collected the species' distribution is broader than previously thought and seems to be more abundant than what was known (USFWS, 2011). Available data seems to suggest a historical decline in numbers (USFWS, 1986). The species is considered widely distributed, but not uniformly abundant across the island. It has been reported in all of the municipalities of mainland Puerto Rico. The PR boa was considered relatively rare by the 1900s and is probably less abundant now than it was in Pre-Columbian times, when Puerto Rico had an extensive forest cover. However, it is considered more abundant today than previously thought at the time of listing and more abundant in the karst region of the north and less abundant in the dry southern region of the Island. The PR boa has cryptic coloration and habits, and attempting to determine a population estimate for this widely distributed species is challenging. Based on the above, the resulting current initial population size of the PR boa could range from 37,903 to 189,515 boas (0.1 and 0.5 boa/ha multiplied by 379,029 ha of PR boa suitable habitat) for the entire Island. (USFWS, 2021a).

Threats and Stressors

Stressor: Habitat modification and destruction (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Despite the above conservation efforts and additional proposals to protect the northern karst region of Puerto Rico by non-government organizations, part of this area is still in private ownership. This region has been previously affected by deforestation and land movement for agricultural purposes, commercial, industrial, highway, and urban development. At present, habitat modification is still occurring within the region, transforming the karst landscape by removing haystacks ("mogotes"), filling sinkholes and caves, filling wetlands, and paving over surfaces to facilitate intense uses of the land (Lugo et al. 2001). The Service has identified that riparian areas along streams are prone to direct and indirect impacts by poor development practices during and after project construction. Joglar et al. (2007) discussed how habitat loss and landscape fragmentation have become another concern in the conservation of the PR boa. The authors explained that habitat destruction is increasing and may disrupt natural population

dispersal and gene flow (USFWS, 2011).

Stressor: Hunting (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Illegal hunting of boas for oil and meat is reported in the literature. The hunt of PR boas to extract its fat was reported in the 1930s by Grant (1933) and supported by Rivero (1998), indicating that snake "oil" is used as a medicinal remedy. Illegal hunting has been identified as a factor contributing to the species' decline (Pérez-Rivera and Vélez 1978). More recent authors, after conducting interviews with local people during their investigations, agree that this practice still continues to date (Reagan 1984, Puente-Rolón 1999, Joglar 2005). The extent or effect of illegal hunting is not known. Throughout the years, various researchers have interviewed people in immediate areas of their research sites corroborating that killing boas due to innate fear, religious prejudice and ignorance persists (Bird-Picó 1994, Puente-Rolón and Bird-Picó 2004, Joglar 2005). Boas are also being killed because they regularly eat poultry and their eggs (Wiley 2003). Boas are also accidentally killed by vehicles each year while crossing roads within the Caribbean National Forest and elsewhere in the island (Reagan and Zucca 1982, Wiley 2003) (USFWS, 2011).

Recovery

Reclassification Criteria:
Not specified

Recovery Priority Number: 11C

Delisting Criteria:
The amended delisting criteria for the PR boa are as follows: 1. At least three (3) PR boa populations (moist limestone, wet limestone, and montane forest regions) occupy at least 50% of its suitable habitat, and populations are distributed island wide (addresses Factors A, C and E). 2. Populations show a stable or increasing population trend, evidenced by natural recruitment and multiple age classes (addresses Factors A, C and E). 3. Threat reduction and management activities have been implemented to a degree that the species will remain viable for the foreseeable future (addresses Factor E) (USFWS, 2019).

Recovery Actions:
- Determine status of present population (USFWS, 1986).
- Conduct basic ecological studies (USFWS, 1986).
- Update Recovery Plan (USFWS, 1986).
- Determine degree of human persecution (USFWS, 1986).
- Protect remaining population (USFWS, 1986).
- Protect remaining population (USFWS, 1986).
- ADDITIONAL SITE SPECIFIC RECOVERY ACTIONS: 1. Develop and implement monitoring protocols to ensure that the species' populations remain stable or with an increasing trend, and to have evidence of natural recruitment and multiple age classes. This action relates to recovery task 1: Determine status of present population. 2. Develop prime or suitable

habitat maps to include specific translocations guidance as part of the conservation measures for the Puerto Rican boa. This action relates to recovery task 2: Conduct basic ecological studies. 3. Conduct a landscape analysis focusing on caves with resident populations and the connections of these caves with forested habitat. This action relates to recovery task 2: Conduct basic ecological studies. 4. Ensure that properties where the PR boa's cave-associated populations have been identified and their adjacent prime habitats are protected by long-term conservation mechanisms. This action relates to recovery task 5: Protect remaining populations (USFWS, 2019).

- Conduct quantitative efforts to estimate the relative abundance of the PR boa (USFWS, 2011).
- Revise and update the PR boa Recovery Plan with current information on the species and establish delisting criteria (USFWS, 2011).
- Investigate the effect habitat loss fragmentation on the PR boa (USFWS, 2011).
- Refine habitat description and suitability habitat models for the PR boa based on GAP analysis and other geographical related tools (USFWS, 2011).
- Investigate if translocation is an effective tool for protecting the PR boa when jeopardized by habitat destruction (USFWS, 2011).
- Promote research on the PR boa through the academia (USFWS, 2011).
- Develop public education and outreach programs aimed at reducing the public prejudice against the PR boa (USFWS, 2011).
- Develop more cooperative agreements with local partners (i.e., federal and Commonwealth agencies, NGOs, and private landowners) for the conservation and protection of more habitat for the PR boa (USFWS, 2011).

References

USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/speciesProfile/. Accessed April 2016

U.S. Fish and Wildlife Service. 1986. Puerto Rican Boa Recovery Plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 21 pp

USFWS 2011. Puerto Rican Boa (Epicrates inornatus) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Southeast Region. Caribbean Ecological Services Field Office Boquerón, Puerto Rico.

USFWS 2011. Puerto Rican Boa (Epicrates inornatus) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Southeast Region. Caribbean Ecological Services Field Office Boquerón, Puerto Rico

U.S. Fish and Wildlife Service. 1986. Puerto Rican Boa Recovery Plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 21 pp.

U.S. Fish and Wildife Service. 1986. Puerto Rican Boa Recovery Plan. U.S. Fish and Wildife Service, Atlanta, Georgia. 21 pp. USFWS. 2021a. Species status assessment report for the Puerto Rican boa (Chilabothrus inornatus). Version 1.2. April 2021. Boquerón, PR. 67pp.

USFWS. 2011. Puerto Rican Boa (Epicrates inornatus) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Southeast Region. Caribbean Ecological Services Field Office Boquerón, Puerto Rico.

U.S. Fish and Wildlife Service. 1986. Puerto Rican Boa Recovery Plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 21 pp.

U.S. Fish and Wildlife Service. 2019. Amendment 1 to the Puerto Rican Boa Recovery Plan (Chilabothrus inornatus, formerly Epicrates inornatus).

USFWS 2011. Puerto Rican Boa (Epicrates inornatus) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Southeast Region. Caribbean Ecological Services Field Office, Boquerón, Puerto Rico.

SPECIES ACCOUNT: *Epicrates (=Chilabothrus) monensis granti* (Virgin Islands tree boa (=Chilabothrus))

Species Taxonomic and Listing Information

Commonly-used Acronym: VI Boa

Listing Status: Endangered; 10/13/1970; Southeast Region (R4)

Physical Description

The Virgin Islands tree boa is not easily confused with other snakes within its range. The adult body color is light plumbeous brown with darker brown blotches partially edged with black. The dorsal blotches are angulate and frequently reach the ventral scales. The dorsal surface has a general blue-purple iridescence. The ventral surface is greyish-brown speckled with darker spots. In contrast with the adult coloration, neonate E. m. granti dorsal ground color is light grey punctuated with black blotches. An ontogenetic color change is common to most members of the genus Epicrates (USFWS, 1986).

Taxonomy

Note Genus has changed from Epicrates to Chilabothrus (ITITS, 2016). The Virgin Islands tree boa belongs to the Family Boidae of the Suborder Serpentes. The genus Epicrates is distributed throughout Central America, northern South America, and the Greater Antilles. This taxon was erroneously thought to be a subspecies of the Puerto Rican boa, Epicrates inornatus, (Stull, 1933) until Sheplan and Schwartz (1974) demonstrated its affinities with Epicrates monensis, Thus Epicrates monensis demonstrates a disjunct range, with one subspecies (monensis) endemic to Isla de Mona and the other (granti) distributed on several islands of the Puerto Rico Bank east of Puerto Rico (including Cayo Diablo, Eastern St. Thomas, Tortola, Guana, Greater Camanoe, Necker Cay, and Virgin Gorda (Nellis et al., 1983)) (USFWS, 1986).

Historical Range

The historical distribution of the VI boa suggests that this species was widely distributed throughout Puerto Rico and the Virgin islands, including the northeastern side of Puerto Rico, the offshore cay of Cayo Diablo, Culebra Island, St. Thomas in USVI; Tortola, and Virgin Gorda in British Virgin Islands (BVI) (Grant 1932; Sheplan and Schwartz 1974; Nellis et al. 1983; Tolson and Piñero 1985; USFWS 1986; Mayer and Lazell 1988; Tolson 1989) (USFWS, 2009).

Current Range

The available data suggests that VI boa currently exhibits a fragmented distribution within its range and is restricted to few islands within the region (USFWS 1986; Tolson 1986b; García 1992; Tolson 1996; Tolson 2004a). Tolson (1996) hypothesizes that the current distribution is the result of a long history of species decline and local extirpations. Surveys to locate additional VI boa populations were conducted on several islands and cays of Puerto Rico and Virgin Islands. Cornish (1986) searched for the VI boa at nine locations at the eastern side of the St. Thomas Island previously considered by Nellis et al. (1983) as boa habitat. However, he did not find VI boas during his surveys but reported one shed skin of the VI boa at Turtle Cove. Tolson (1991) searched for the VI boa from 1986 to 1989 in 10 locations in Puerto Rico and 10 small islands in USVI. García (1992) and Puente-Rolón (2001) also surveyed additional areas in Puerto Rico

(USFWS, 2009).

Distinct Population Segments Defined

No

Critical Habitat Designated

Yes;

Life History

Feeding Narrative

Adult: The bulk of my diet seems to consist of Anolis cristatellus. Limited observations indicate that E. m. granti feeds by gliding slowly along branches seeking sleeping lizards. In Cayo Diablo, a small boa pursued an Anolis 3 m up in a Coccobola tree (Nellis, per sobs.). Schmidt (1928) reported finding the tail of Anolis cristatellus (= A. monensis) in the stomach of a preserved specimen of E. m. monensis. Tolson and Pinero (1985) found the greatest concentration of E. m. granti capture sites in areas where Anolis cristatellus populations are most dense. Captive specimens refused to eat dead mice but consumed Sphearodactylus macrolepis and Anolis cristatellus (Nellis et al., 1983). Sheplan and Schwartz (1974) reported taking a house mouse (Mus musculus) from the stomach of a preserved specimen (WPM 1569) captured on St. Thomas. Epicrates monensis granti, like other species of Epicrates probably opportunistically consumes nestlings of smaller bird species (USFWS, 1986).

Reproduction Narrative

Adult: The Recovery Plan (USFWS 1986) explains that the VI boa has a longevity that can exceed 10 years with an annual reproductive cycle. However, Tolson (1986a) found that the VI boa had a biannual reproductive cycle and found that the longevity of this species may exceed 20 years (Tolson 1996). Consequently, a female VI boa has the potential to produce 50-75 offspring during her lifetime (USFWS, 2009).The Plan (USFWS 1986) suggests that the growth and size class data indicate that the species can reach reproductive maturity in as little as three years. However, Tolson (1986a) reports one marked and released female that reached the size close to sexual maturity in only one year. According to Tolson (1986a), the smallest gravid female reported in the wild was an individual with a mass of 84g (3 oz) and snout-vent lengths of 521mm (20.5 in) in the Cayo Diablo population and she gave birth to 4 young boas while in captivity (USFWS, 2009).In the genus Epicrates, courtship and copulation usually take place from February through May, with parturition in late August through October (Tolson, 1984). Epicrates monensis granti follows this pattern of reproductive timing on Cayo Diablo (Tolson and Pinero, 1985) (USFWS, 1986).

Spatial Arrangements of the Population

Adult: Uniform (inferred from USSFWS, 1986)

Environmental Specificity

Adult: Broad (inferred from USFWS, 1986)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1986)

Site Fidelity

Adult: High (inferred from USFWS, 1986)

Habitat Narrative

Adult: On St. Thomas, the Virgin Islands tree boa is found in xeric forest habitat characterized by step slopes with poor rocky soils (Nellis et al., 1983). Vegetation is second growth open woodland…Grant (1932b) remarked that the boa 'inhabits rocky cliffs on Tortola and Guana Island' (USFWS, 1986)).The boa is also found on low profile islets. Cayo Diablo is a cemented dune (fossilized sand dune) islet with a maximum elevation of 15 m and an extremely simple vegetational profile, the tallest vegetation is an open stand of sea grape, which borders the northwest corner of the island. The grove reaches a height of 5 m in the densest sections. Snakes are most abundant in Coccobola stands, but are also found in every type of vegetation except very low succulent cover close to the high tide line (USFWS, 1986). During the day, snakes seek concealment, often on the ground (USFWS, 1986). Uniform spataila arrangement, broad environmental specificity, high ecological integrity, low tolerance range and high site fidelity are inferred form this species habitat information found in USFWS, 1986).

Dispersal/Migration

Motility/Mobility

Adult: High (inferred from USFWS, 1986)

Migratory vs Non-migratory vs Seasonal Movements

Adult: Non-migratory (inferred from USFWS, 1986)

Dispersal

Adult: Low (inferred from USFWS, 1986)

Immigration/Emigration

Adult: Unlikely (inferred from USFWS, 1986)

Dispersal/Migration Narrative

Adult: Most snakes are highly mobile and non-migratory. Low dispersal is inferred based on the low number of known populations and the fact that an island snake species would find it difficult to disperse beyond the island.

Population Information and Trends

Population Trends:

Stable (USFWS, 2009)

Species Trends:

Increasing (USFWS, 2009)

Resiliency:

In Puerto Rico and USVI (excluding British Virgin Islands populations for which we have no data), there are 6 known populations of VI boa, 2 we classified as having moderate resilience, 1 with moderately low resilience, 2 with low resilience, and 1 with no resilience due to presumed extirpation (Table 2). Our classifications of resilience rely heavily on habitat characteristics in the absence of highly certain population size or trend estimates; more regular monitoring and improved survey and abundance estimation methods would improve our understanding of the resilience of these populations. Both populations classified as moderately resilient (Cayo Diablo and USVI Cay) occur on small offshore islands that are free of exotic rats and cats and are protected for conservation. Primarily because of the protected and exotic-mammal-free state of the habitat, these populations are considered to be fairly resilient to demographic and environmental stochastic events and disturbances (e.g. fluctuations in demographic rates, variation in climatic conditions, illegal human activities). Status of the USVI Cay population suggests a potential decline in abundance, and the loss of two prey species, possibly as a result of density dependence as the population approached carrying capacity after reintroduction. Three of the populations with low or moderately low resilience (Río Grande, Culebra, and St. Thomas) occur on larger and higher-elevation islands, which provide more protection from storm surges, but come with growing human populations and increasing human-boa interactions, habitat loss and fragmentation from development, and exotic cats and rats. In the face of these threats, these 3 populations are not expected to well withstand stochastic demographic and environmental events and disturbances. The remaining Cayo Ratones population has no resilience since boas were not detected during the most recent surveys (2018 and 2021) and thus is presumed extirpated (USFWS, 2022).

Representation:

Given the information available, there is not a clear and readily apparent strategy for considering representation for this species. Input from the literature and species experts ranged from considering all populations a single representative unit, to considering each population a representative unit, to refraining from calling any grouping a representative unit. Here, we capture the uncertainty and discussion around this topic and discuss representation under one idea, but acknowledge that there are other ways to think about it and more research is needed to better understand the adaptive potential and differences between VI boa populations. A range-wide genetic analysis of VI boa showed that there was little genetic variation within the species (Rodríguez-Robles et al. 2015), supporting the idea that there is only one representative unit of VI boa. The authors recommended managing the entire species as a single genetic population, and promoting interbreeding across populations to maintain genetic diversity. The same study, however, found that each sampled island, and each sampled locality within the same island, have private mtDNA haplotypes, indicating a lack of gene flow between islands/populations. These results suggest that each population has a different genetic signature, perhaps as a result of genetic adaptations to their local environment, or genetic drift with increasing isolation of small populations. The reintroduction program took this view, and managed captive populations sourced from Cayo Diablo and St. Thomas separately (Tolson 1996b). To minimize the chances of introducing individuals poorly suited to their new environment, the captive Cayo Diablo population was used to found the reintroduced population on nearby Cayo Ratones (currently presumed extirpated), and the captive St. Thomas population was used to found the reintroduced population on the nearby USVI cay (Tolson 1996b). In addition to genetic differences, these populations also have noticeable phenotypic differences from each other. Phenotypic differences are not just limited to differences between USVI and Puerto Rican populations (different coloration; Tolson 1996b); Cayo Diablo reportedly has phenotypic differences even from the Río Grande and Culebra populations (lighter coloration on Cayo Diablo; P. Tolson, pers. communication). The Río Grande population also occurs in a different habitat type (subtropical moist forest) than the others (subtropical dry or littoral forest; Tolson 1996b). In light of this information, we here consider each of the 4 natural populations (not introduced and excluding the British Virgin Islands populations that we did not assess) a representative unit (Table 3). The Cayo Diablo population is considered moderately resilient, and was the source for the presumed extirpated Cayo Ratones population. Therefore, there is only 1 population representing the Cayo Diablo genetic signature. The USVI cay population was sourced from St. Thomas, so there are 2 populations with St. Thomas representation, with none considered to be highly resilient at this time. The other 2 natural populations, Culebra and Río Grande, both characterized as having moderately low or low resilience, have not been used for captive breeding and reintroduction, so have no additional populations on other islands with the same genetic characteristics. Overall, only 1 of 4 representative units has at least 1 moderately resilient population. Because of how representative units were defined here, any redundancy within representative units is the result of sourcing reintroductions from existing natural populations; low redundancy within representative units is a natural consequence of the species occurring in isolated island populations. While currently we can consider the USVI Cay reintroduced population (currently with moderate resilience) to be a redundant population sharing the same genetic signature and adaptive potential as their its source population (St. Thomas), all of the islands occupied by VI boa are isolated from each other. Without human-mediated movement of boas between islands, any reintroduced population is expected to diverge genetically from its source population over time, and may at some point in the future (decades to centuries; Reynolds et al. 2015) be different enough to be considered their own unique representative unit (USFWS, 2022).

Redundancy:

Redundancy for the VI boa, a narrow ranging endemic, is inherently low. With 5 populations in Puerto Rico and USVI (and one or more populations in the British Virgin Islands of unknown status), and only 2 of those considered currently moderately resilient, the species is not well buffered against the effects of catastrophic events. Catastrophic events that could affect single or multiple VI boa populations include but are not limited to hurricanes (multiple populations), colonization or recolonization of exotic mammals to cays where they are not currently present (generally single populations, but rats could use cays as stepping stones, increasing the risk of colonization for nearby cays), disease outbreaks, and fires (single populations). The lack of redundancy in the face of hurricane threats is well illustrated by the path of Hurricane Maria in 2017 (Figure 6). The entire range of the VI boa in Puerto Rico and USVI were subjected to hurricane force winds (> 64 knots) as the hurricane passed over, first as a Category 5 hurricane, weakening to a Category 4 hurricane over the Puerto Rico mainland. Hurricane Hugo in 1989 followed a similar path and caused extensive habitat damage, striking the range of the VI boa first as a Category 4 hurricane and weakening to a Category 3 hurricane. The exact historic distribution (redundancy) of the VI boa is unknown, but their present disjoint distribution suggests that they were once more widely distributed across small islands within their range, which have been subject to local extirpations from habitat degradation, invasive species, and historic climate and sea level changes (USFWS, 2022).

Number of Populations:

6 (USFWS, 2022)

Population Size:

1,300 - 1,500 (U.S. jurisdiction) (USFWS, 2009)

Population Narrative:

USFWS (2009) notes that the species status is stable.The population of the VI boa on Cayo Diablo and Cayo Ratones (cays off the northeast coast of Puerto Rico) were last surveyed in 2004. Miguel García and Alberto Puente-Rolón with the Puerto Rico Department of Natural and Environmental Resources (DNER) conducted a rapid assessment in 2007 providing a snapshot of the species habitat at these cays and suggested that the VI boa should be considered stable (García 2008 pers. comm.). Rats were eradicated from these cays and food source species (i.e., Anolis lizards) were abundant (García 2008 pers. comm.). Surveys of reintroduced VI boa on Steven Key (between St. Thomas and St. John) in 2004 indicated that this population was thriving and stable. The population was composed mostly of adult boas; indicative of substantial food sources (primarily young Iguana iguana) and low predation pressure from yellowcrowned night herons. Rats were also eradicated from this cay (Tolson 2004b). Other populations in Puerto Rico and the U.S. Virgin Islands have not been surveyed (USFWS, 2009).Low resiliency, representation and redundancy are inferred based on low population numbers and low genetic diversity.Currently, the abundance of the species in its range within the US jurisdiction isestimated to be at approximately 1,300 - 1,500 boas, an 18 to 20 fold increase from theknown population after 22 years (USFWS, 2009).   We consider 6 populations for this SSA: In Puerto Rico the populations are Cayo Diablo, Cayo Ratones, Culebra, and Río Grande; in USVI there is a population on St. Thomas and a reintroduced population on a USVI cay. One or more populations exist in the British Virgin Islands, but are only briefly described here because data are severely limited, although they could be considered as potential source populations for future reintroductions. Other populations may occur on islands in Puerto Rico and USVI, but VI boa habitat and activity patterns make them difficult to find, and no other populations are confirmed to be extant at this time despite extensive searching (USFWS, 2022).

Threats and Stressors

Stressor: Habitat destruction (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: VI boa habitat occurs in subtropical dry forest and subtropical moist forest. Today, we know that the VI boa apparently uses less than 0.05% of this suitable habitat available in PR and USVI. In contrast, in Tortola, BVI the species is common and found in habitats ranging from mangrove to moist mountain forest at elevations less than 300 m (984.25 ft) (i.e. Sage Mountain 290m (951.44 ft)).   In Puerto Rico and the USVI, some of the locations where the species has been described are threatened by habitat modification and habitat fragmentation by urban developments. Some VI boa habitat within the island of St. Thomas, and the municipality of Río Grande and Culebra in Puerto Rico is threatened with urban development pressure. (Tolson 2008 in litt; Puente-Rolón 2001; Kojis 2008 in litt; and Platenberg 2008 unpublished data). In St. Thomas, habitat may be declining due to the development for resorts, condos, and related infrastructure; becoming more constricted and isolated (Tolson 2008 in litt; Platenberg 2006 unpub. data). However, most offshore cays are part of the Territorial government and / or protected as wildlife refuges. In Culebra Island, the VI boa habitat in privately owned land is currently under pressure for urban and tourism development and habitat modification by deforestation. However, more than 1000 acres of VI boa suitable habitat is protected within the Service’s Culebra National Wildlife Refuge. The Service is providing technical assistance to project

developers to modify project plans to avoid destruction of suitable VI boa habitat and ensure conservation of these areas. It is important to note that 65% of known boas occur in small offshore islets managed for conservation. Cayo Ratones and Cayo Diablo are included as part of DNER La Cordillera Natural Reserve and Steven Key in USVI is managed and protected by the DPNR. The protection of these islets is ensured by local laws and regulations, and ultimately by the ESA. We believe that the imminence of this threat is low because the majority of the currently known populations are in islands managed for conservation; some VI boa occur in lands in a National Wildlife Refuge; and federally funded or permitted projects on private lands may require ESA section 7 consultation (USFWS, 2009).

Stressor: Predation (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Based on the information mentioned above, predation by cats should be considered as a current threat to the species. Since rat control projects have been conducted in the islands where the species is present, rats are not to be considered a threat at these areas. Documented predation by cats has been limited. Hence, the Service considers predation by cats and rats to be reduced at this time (USFWS, 2009).

Stressor: Intentional Killing (Human) (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Intentional killing of genus Epicrates due to innate fear or superstitious beliefs is well documented in the literature (Bird-Picó 1994; Puente-Rolón and Bird-Picó 2004; Joglar 2005). According to USVI DPNR-DFW (Platenberg 2006 unpub. data), about ten percent (N=13 individuals) of the VI boa records in St Thomas are from dead boas killed by humans on their properties. Likewise, the first report for Culebra Island and Humacao was from dead boa killed by a local. However, most of those records came from anecdotal reports. No systematic studies have been conducted to determine the effects of intentional killing on the VI boa. The Service is not aware of a law enforcement case related to VI boa in PR or the USVI (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Climate change and sea level rise is a possible threat for the VI boa in the future. Increase in sea level may affect the species and its habitat in coastal areas and offshore islets. New information reveals that 65% (N=920 individuals) of the known population occurs on offshore islets (less than 2 acres) with a maximum elevation of 15 meters (42 ft). However, because the change in sea level is a long term process and may occur a long period of time, this threat should be considered as very low and non-imminent (USFWS, 2009).

Stressor: Fire (Human caused) (USFWS, 2008)
Exposure:
Response:
Consequence:

Narrative: The habitat where the species have been found in PR and USVI is mostly coastal dry forest. This type of forest is susceptible to human-related catastrophic events such as fires. The rapid growth of grass can increase fuel build-up that may further the impact of fire. In Culebra Island, Cayo Ratones and Cayo Diablo, the VI boa occurs in areas with easy public access and a high potential of being negatively impacted by human activities such as intentional fire. In Cayo Ratones and Cayo Diablo, DNER personnel implement a management and educational program during the dry season to prevent fires. In Culebra Island, the Culebra National Wildlife Refuge and DNER implements a fireprevention and management program during the dry season. Because the Service and the DNER implement a fire-prevention and management program during the dry season, this factor should be considered as a threat, but low and non-imminent (USFWS, 2009).

Recovery

Reclassification Criteria:
Need a final, approved recovery plan containing objective, measurable criteria (USFWS, 2009)?

Adequacy of recovery criteria (USFWS, 2009)

Interim goal: Reclassify from Endangered to Threatened (USFWS, 2009)

Recovery Priority Number: 9C

Delisting Criteria:
The amended delisting criteria for the VI boa are: I. Existing two (2) VI boa populations with the highest resiliency (Cayo Diablo and USVI Cay) exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor A, C, and E). 2. Establish three (3) additional populations that show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor A, C, and E). 3. Threats are reduced or eliminated to the degree that the species is viable for the foreseeable future (addresses Factor A, and C and E) (USFWS, 2019).

Recovery Actions:

- The VI boa has a final recovery plan, but it is outdated and does not contain measurable criteria. The Plan describes the recovery objective as to attain a population level at which point the species can be delisted. It only describes a objective to reduce the classification of the species from endangered to threatened within a 10 year period. No quantitative recovery level was defined due to the absence of information on population sizes and limiting factors. The Plan recommends conducting comprehensive status surveys and ecological studies of the species before determining specific recovery levels for the VI boa (USFWS, 2009).
- The 5 listing factors have not been addressed and recovery criteria no longer reflect the best and most up to date biology and habitat information (USFWS, 2009).
- Based on the information we gathered for this review, the interim reclassification criteria have been accomplished as follows: a) At present, the populations of the VI boa at Cayo Diablo, Cayo Ratones and Steven Key are considered stable because of the age distribution and population composition (Tolson 2004a; Tolson et al. 2008). According to the information summarized in this review (Table 1), the population in these three cays and St. Thomas is at around 1,300 boas, an 18 fold increase from the 1985 population levels.

Although the number of individuals at Río Grande (PR) and Culebra Island (PR) has not been determined, individuals have been sighted (Puentes-Rolón 2008 pers. comm.). Similarly, the species has been sighted in St. Thomas and the population estimated by Tolson (1991) is about 400 individuals. b) Two populations of the VI boa were successfully established by the reintroduction of the species from captive breeding programs in mongoose and rat-free habitat. The first population was established in Cayo Ratones (PR) in 1993 and the second was established in Steven Cay (USVI) in 2002. These two populations are considered by Tolson et al. (2008) as thriving populations. c) In 1985, a rat control program was started in Cayo Ratones (PR), Congo Key and Steven Key, (USVI) which was identified as potentially suitable for the reintroduction of the species. Rats have been eliminated on Cayo Ratones and on Steven Key in USVI (Tolson et al. 2008) and VI boas are established at Cayo Ratones and Steven Key (USFWS, 2009).

- Revise the recovery plan to include new information on the biology of the species and the development of measurable criteria for delisting the species (USFWS, 2009).
- Develop a Population Viability Analysis (PVA) for the VI boa to determine the minimum viable population size needed to sustain the species over 50 years (USFWS, 2009).
- Conduct quantitative efforts to estimate relative abundance of the species at Rio Grande and Culebra Island in PR; and at St. Thomas in USVI (USFWS, 2009).
- Conduct additional surveys in traditional and nontraditional areas with suitable habitat for the species in PR and USVI, which include Vieques and St. John, to determine density and distribution (USFWS, 2009).
- Refine habitat description and suitability based on GAP analysis and other geographical related mechanisms (USFWS, 2009).
- Assess VI boa predator/prey relationships on non-islet environments (USFWS, 2009).
- Conduct comparative DNA analysis within populations distinct and between other populations, including that of Tortola, BVI to determine possible genetic differences or possible genetic threats (USFWS, 2009).
- Continue to support predator eradication (cats and rats) from offshore cays and other VI boa habitat (USFWS, 2009).
- Reinitiate the captive breeding program and reintroduction program of the species in protected and predator-free areas. Captive breeding and release activities were conducted in the 1990’s. At the present time, VI boas are still in captivity (USFWS, 2009).
- Develop public education and outreach programs for the VI boa at Rio Grande and Culebra Island in PR, and at St. Thomas, USVI (USFWS, 2009).
- Develop cooperative agreements with local jurisdictions and private landholders for the conservation and protection of suitable habitat for the VI boa in PR and USVI (USFWS, 2009).

References

U.S. Fish and Wildlife Service. 1986. Virgin Islands Tree Boa Recovery Plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 26 pp

U.S. Fish and Wildlife Service. 2009. Virgin Islands Tree Boa (Epicrates monensis granti) 5-Year Review: Summary and Evaluation U.S. Fish and Wildlife Service Southeast Region Caribbean Ecological Services Field Office Boqueron, Puerto Rico.

U.S. Fish and Wildlife Service. 2009. Virgin Islands Tree Boa (Epicrates monensis granti) 5-Year Review: Summary and Evaluation U.S. Fish and Wildlife Service Southeast Region Caribbean Ecological Services Field Office Boqueron, Puerto Rico. USFWS. 2022. Virgin Islands Tree Boa (Chilabothrus granti) Species Status Assessment. Version 1.1. USFWS. Region 4. Atlanta, GA. 72 pages.

U.S. Fish and Wildlife Service. 2019. Amendment 1 to the Virgin Island Tree Boa Recovery Plan (Chilabothrus granti, formerly Epicrates monensis granti).

USFWS. 2009. Virgin Islands Tree Boa (Epicrates monensis granti) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Southeast Region Ecological Services Boquerón, Puerto Rico.

SPECIES ACCOUNT: *Eumeces egregius lividus* (Bluetail mole skink)

Species Taxonomic and Listing Information

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

Physical Description

The mole skink (Eumeces egregius) is a small, fossorial lizard that occupies xeric upland habitats of Florida, Alabama, and Georgia (Mount 1963). Five subspecies have been described (Mount 1965), but only the blue-tailed mole skink (Eumeces egregius lividus) is federally listed. It requires open, sandy patches interspersed with sclerophyllous vegetation (Service 1999). The historic and anticipated future modification and destruction of xeric upland communities in central Florida were primary considerations in listing the blue-tailed mole skink as threatened under the Act in 1987 (52 FR 42662 Mount (1965) described the blue-tailed mole skink largely on the basis of a bright blue tail in juveniles and restricted this subspecies to the southern Lake Wales Ridge (LWR) in Polk and Highlands Counties. Christman (1978b) limited the range of blue-tailed mole skinks to these two counties, but later added Osceola County to the range, based on the collection of a single juvenile of the subspecies just north of the Polk County line on the LWR (Christman 1992, FNAI records). Analysis of mtDNA (Branch et al. 2003) supports Mount's (1965) hypotheses that blue-tailed mole skinks from the lower LWR represent the ancestral stock with radiation from there. Genetic analysis also indicates high population structure with limited dispersal in mole skinks among sandy habitats (Branch et al. 2003). The blue-tailed mole skink reaches a maximum length of about 5 inches, and the tail makes up about half the body length. The body is shiny, and brownish to pink in color, with lighter paired dorsolateral stripes diverging posteriorly (Christman 1978b). Males develop a colorful orange pattern on the sides of the body during breeding season. Juveniles usually have a blue tail (Christman 1992; P. Moler, FWC, personal communication 1998). Regenerated tails and the tails of older individuals are typically pinkish. The legs are somewhat reduced in size and used only for surface locomotion and not for "swimming" through the sand (Christman 1992).

Taxonomy

North of range, this subspecies is replaced by or intergrades with E. e. onocrepis. (NatureServe, 2015)

Historical Range

See Current

Current Range

The historic and anticipated future modification and destruction of xeric upland communities in central Florida were primary considerations in listing the blue-tailed mole skink as threatened under the Act in 1987 (52 FR 42662). Almost 90 percent of the xeric upland communities on the LWR have already been lost because of habitat destruction and degradation due to residential development and conversion to agriculture, primarily citrus groves (Turner et al. 2006). Remaining xeric habitat on private lands is especially vulnerable because projections of future human population growth suggest additional demands for residential development within the range of the blue-tailed mole skink. Campbell and Christman (1982) characterized blue-tailed mole skinks as colonizers of a patchy, early successional, or disturbed habitat type, which occurs throughout the sandhill, sand pine scrub, and xeric hammock vegetative associations as a result of biological or catastrophic factors. Susceptibility of mature sand pine to wind-throw may be an important factor in maintaining bare, sandy microhabitats required by blue-tailed mole skinks and other scrub endemics (Myers 1990). At the time of Federal listing, there were 20 locality records for the blue-tailed mole skink. Currently, 43 sites are known. The increase in locality records is largely the result of more intensive sampling of scrub habitats in recent years and does not imply that this species is more widespread than originally supposed. Of the known locations, only 13 occur on public land or on private land protected under conservation easement. Turner et al. (2006) suggested blue-tailed mole skinks may be under-represented in the reserve network of protected public lands, but could not determine if their absence is a result of exclusion or sampling effort. It is likely continued residential and agricultural development of xeric upland habitat in central Florida has destroyed or degraded extensive tracts of habitat containing the blue-tailed mole skink. Estimates of habitat loss range from 60 to 90 percent, depending on the xeric community type (Christman 1988; Christman and Judd 1990; Kautz 1993; Center for Plant Conservation 1995). Blue-tailed mole skinks are known to be present on sites which total 52.4 percent of the 21,597 acres (8,740 ha) of Florida scrub and high pine that is currently protected (Turner et al. 2006). However, the extent of potential habitat that is actually occupied is unknown, as is their total population size. As noted above, this species appears to be patchily distributed, even in occupied habitat (Mount 1963; Christman 1992). Unlike sand skinks, their tracks cannot be easily detected in the sand, and most of the extant scrub sites on the LWR have not been adequately surveyed for blue-tailed mole skinks, including protected sites. A density study of blue-tailed mole and sand skinks was conducted in 2004-2005 by Christman (2005). Only two blue-tailed mole skinks were observed in the enclosures (mean density = 3.3/hectare, 1.3/acre) relative to at least 84 sand skinks (ratio = 1:41). Christman (1992) suggested only 1 blue-tailed mole skink is encountered for every 20 sand skinks. Other range-wide pitfall trap data on the LWR revealed a blue-tailed mole skink to sand skink ratio of 1:1.89 based on 54 total skinks captured in six trap arrays (Christman 1988), 1:4.3 based on 332 total skinks in 58 trap arrays (Mushinsky and McCoy 1991), and 1:2.7 based on 49 total skinks in 31,640 pitfall trap-days (Meshaka and Lane 2002). Mushinsky and McCoy (1991) confirmed that detection rates for blue-tailed mole skinks increased with sampling effort.

Distinct Population Segments Defined

No

Critical Habitat Designated

No;

Life History

Feeding Narrative

Adult: Sand skinks and blue-tailed mole skinks generally partition rather than compete with one another for resources. Sand skinks are primarily fossorial; they move or “swim” below the surface of the ground in sandy soils and take prey below the surface. Blue-tailed mole skinks are semi-fossorial; they hunt primarily at the soil surface or at shallow depths to 2 inches and consume mostly terrestrial arthropods (Smith 1977, Service 1993b). Foraging activities usually occur during the morning or evening. Roaches, crickets, and spiders make up the bulk of the diet (Mount 1963). Their diet is more generalized than that of the fossorial sand skink, which probably reflects their tendency to feed at the surface (Smith 1982). Like sand skinks, mole skinks show an activity peak in spring (Mount 1963, Smith 1982).

Reproduction Narrative

Adult: Lays clutch of 2-9 eggs, April-June. Female attends eggs. Eggs hatch in about 4-7 weeks. Female attends eggs during incubation (Fitch 1970). Probably sexually mature in first year.; (NatureServe, 2015). The reproductive biology of the blue-tailed mole skink is poorly known. Reproduction is presumably very much like that of the peninsula mole skink, E. e. onocrepis, where mating occurs in the fall or winter. In the peninsula mole skink, two to nine eggs are laid in a shallow nest cavity less than 12 inches below the surface. The eggs incubate for 31 to 51 days, during which time the female tends the nest. Individuals probably become reproductively active at 1 year of age (Mount 1963, Christman 1978a). No data are available on blue-tailed mole skink home ranges or dispersal.

Habitat Narrative

Adult: A variety of xeric upland communities provide habitat for the blue-tailed mole skink, including rosemary and oak-dominated scrub, turkey oak barrens, high pine, and xeric hammocks. Areas with few plant roots, open canopies, scattered shrub vegetation, and patches of bare, loose sand provide optimal habitats (Christman 1988, 1992). Within these habitat types, blue-tailed mole skinks are typically found under leaves, logs, palmetto fronds, and other ground debris. Shaded areas presumably provide suitable microhabitat conditions for thermoregulation, egg incubation, and foraging (Mount 1963). Blue-tailed mole skinks tend to be clumped in distribution with variable densities that may approach 25 adults per acre (Christman 1992). The distribution of blue-tailed mole skinks appears to be closely linked to the distribution of surface litter and, in turn, suitable microhabitat sites. 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.). Either natural fires started by lightning or prescribed burns are necessary to maintain habitat in natural scrub ecosystems. However, if fire occurs too frequently, leaf litter might not build up sufficiently to support skink populations. At Archbold Biological Station (ABS), sand skinks appear to be most abundant after 10 years of leaf litter development. The ideal fire frequency to maintain optimal leaf litter development for skinks likely varies by site and other environmental conditions (Mushinsky 2011, University of South Florida, pers. comm.).

Dispersal/Migration

Migratory vs Non-migratory vs Seasonal Movements

Adult: Non-migratory

Population Information and Trends

Number of Populations:

31 (USFWS, 2021)

Population Size:

2500 to >1,000,000 individuals (NatureServe, 2015)

Population Narrative:

Small size leads to susceptibility to predation. During the last few decades, about 65% of the skink's habitat has been lost to agriculture (citrus) and residential development (USFWS 1990). Over an even longer period, the percent loss would have been far greater. Decline of >70% Number of individuals is unknown, though it does not seem to be abundant at any site (seems to be much less common than the sand skink [P. reynoldsi] according to S. Christman). Known from more than 20 scrubs, but most are small and isolated (NatureServe, 2015). The Service has little information on the population dynamics of blue-tailed mole skinks within their extant ranges. The skinks' diminutive size and secretive habits make their study difficult. 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, 1992; 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 1999 MSRP contains objective, measurable criteria that reflect the best available and most up-to-date information on the biology of the species and its habitat and addresses the listing factors relevant to the species. Development and agriculture have resulted in the loss of approximately 85 percent of the scrub and sandhill habitats on the LWR, and what remains contains high concentrations of imperiled species, including the blue-tailed mole skink (Turner et al. 2006). Even on protected lands, some blue-tailed mole skink populations are impacted by habitat degradation due to lack of appropriate habitat management. A total of 75,151 acres (Service unpublished data 2020) of potential blue-tailed mole skink habitat was identified on protected Federal, state, local, and private managed conservation areas. Active management is necessary to maintain suitable habitat for skinks. Much of the habitat occurs in small, isolated stands surrounded by residential areas or citrus groves, making them difficult to protect and manage. Many of the fragments are overgrown and in need of restoration. Habitat degradation on these sites continues to be a moderate threat because vegetation restoration and management programs are costly and depend upon availability of funding. Privately-owned sites remain at risk of being developed, and destruction or habitat modification due to improper or lack of management remains a concern. Except for a few locations, we have little information about the status and trends of these skinks. Of the 31 locations on which the blue-tailed mole skink is reported to occur, at least 20 sites are protected, 18 of which are managed (Turner et al. 2006, Weekley et al. 2008, Service unpublished data 2021, USF 2021, Wildlands Conservation 2021). (USFWS, 2021)

Threats and Stressors

Stressor:
Exposure:
Response:
Consequence:
Narrative: Habitat loss, fragmentation, and changes in land use continue to threaten these skinks. In conversion of rural lands to urban use in central Florida where skinks occur is projected to continue over the next 50 years. Overutilization for commercial, recreational and scientific, or educational purposes is not considered to be a threat to this species. Disease and predation were not identified as potential threats in the original listing package, and recent studies have

confirmed this determination. In addition, fire suppression, improper stand management, invasion by exotic plant species, and loss of genetic diversity continue to threaten the existence of the bluetail mole skink and sand skink. Due to the above continued threats, this species continues to meet the definition of threatened under the Act.

Recovery

Recovery Actions:

- The protection and recovery of blue-tailed mole skinks will require habitat loss be stopped and unoccupied but potentially suitable habitat be restored. The existing protection of the blue-tailed mole skink includes a number of private and public preserves within the LWR. Current efforts to expand the system of protected xeric upland habitats on the LWR, in concert with implementation of aggressive land management practices, represent the most likely opportunity for securing the future of this species. Comprehensive land acquisitions that protect areas occupied by the blue-tailed mole skink include the Service's LWR National Wildlife Refuge, and the State of Florida's Conservation and Recreation Lands (CARL) LWR Ecosystem Project (Service 1993a). In summary, little information is available to adequately assess the status and population dynamics of the blue-tailed mole skink. This subspecies is endemic to central Florida and is a habitat specialist that relies on early successional xeric scrub habitat for its continuing existence. Estimates of habitat loss range from 60 to 90 percent, depending on the xeric community type (Christman 1988, Christman and Judd 1990, Kautz 1993, Center for Plant Conservation 1995). Furthermore, the implementation of favorable management practices can create and maintain suitable habitat conditions for both sand and blue-tailed mole skinks, as well as other xeric upland-dependent species. A number of actions over the last 20 years have resulted in conservation benefits to xeric uplands within the extant range of both species. The State of Florida has acquired xeric upland habitat through the CARL, Save Our Rivers, and other P-2000 acquisition programs. Combined, these land acquisition programs have protected 10,000 acres of xeric uplands (Florida Department of Environmental Protection 1998, South Florida Water Management District 1998). The Service has also acquired portions of several small tracts totaling 800 acres as a component of the LWR National Wildlife Refuge. Finally, private organizations, such as The Nature Conservancy and ABS have bought and currently manage xeric uplands within the LWR.

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Land Management and Acquisition • Acquire land or establish conservation agreements in areas where blue-tailed mole skinks are present. • Implement habitat restoration and proper management techniques on scrub and sandhill habitat. • Continue and/or reinstate exotic species removal and prescribed burns in scrub habitat. • Consider variability in the fire regime, including both seasonality and the fire return interval, as it applies to management of the blue-tailed mole skink and its habitat. • Prioritize land acquisition to habitats congruent with existing protected and managed areas in order to obtain the best conservation value of the land for the species. This should be accomplished in coordination with acquisition of property in each of the areas that have genetically distinct populations. • Acquire, protect, and manage additional undeveloped scrub habitat, especially along the middle and southern central ridge of Florida, to effectively protect the species (Telford 2007). Research • Complete the ongoing surveys for blue-tailed mole skinks and compare results with previous studies. • Conduce demographic studies to learn more about the biology of blue-tailed mole skinks. • Conduct additional studies on blue-tailed mole skink density, habitat, and microhabitat conditions throughout the species' range and conduct long-term demographic studies greater than 10 years to determine population trends (Malatesta 2007). • Develop a sampling design that can be used to monitor and assess skink population trends throughout their range on an annual basis. • Establish a survey protocol for blue-tailed mole skinks. • Conduct long-term studies on the effects of mechanical treatment and other management techniques on populations of blue-tailed mole skink (Malatesta 2007). Regulatory • Continue considering genetic distinctions among skink populations throughout their range when conducting section 7 consultations, developing habitat conservation plans, implementing recovery efforts, and when planning reserve designs to maintain the genetic diversity of the species. Other • Promote partnerships to share information on habitat conditions, threats, needed recovery actions, and associated rare scrub biota and conduct collaborative research on scrub habitat conservation. • Maintain updated range maps with new survey data. • Change the listing nomenclature to Plestiodon egregius lividus to reflect what is taxonomically accepted by species experts and based on the best available science. (USFWS, 2021)

References

USFWS 2016. Status of the Species and Critical Habitat: Eumeces egregious lividus (Blue-tailed mole skink). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia.

USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/ecp0/. Accessed April 2016.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A." USFWS. 2021. Blue-tailed Mole Skink (Eumeces egregius lividus) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service South Atlantic-Gulf Region Florida Ecological Services Field Office Vero Beach, Florida. 20 pp.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A."

USFWS. 2021. Blue-tailed Mole Skink (Eumeces egregius lividus) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service South Atlantic-Gulf Region Florida Ecological Services Field Office Vero Beach, Florida. 20 pp.

SPECIES ACCOUNT: *Gambelia silus* (Blunt-nosed leopard lizard)

Species Taxonomic and Listing Information

Commonly-used Acronym: BNLL

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

Physical Description

The blunt-nosed leopard lizard (Gambelia sila) is a relatively large lizard in the Iguanidae family. It has a long, regenerative tail, long, powerful hind limbs, and a short, blunt snout. Adult males are slightly larger than females, ranging in size from 8.7 to 12.0 centimeters (cm) (3.4 to 4.7 inches [in.]) in length (snout to vent), excluding tail. Females are 8.6 to 11.2 cm (3.4 to 4.4 in.) long. Males weigh 36.9 to 42.5 grams (g) (1.3 to 1.5 ounces [oz.]), females weigh 22.7 to 34.0 g (0.8 to 1.2 oz.). Males are distinguished from females by their enlarged postanal scales, femoral pores (visible pores on the underside of the thigh), temporal and mandibular muscles (muscles on the skull that close the jaws), and tail base (USFWS 1998). Although blunt-nosed leopard lizards are darker than other leopard lizards, they exhibit tremendous variation in color and pattern on their backs. Their background color ranges from yellowish or light gray-brown to dark brown, depending on the surrounding soil color and vegetation. Their undersides are uniformly white. They have rows of dark spots across their backs, alternating with white, cream-colored or yellow bands (USFWS 1998). The color pattern on the back consists of longitudinal rows of dark spots interrupted by a series of from seven to ten white, cream-colored, or yellow transverse bands. The cross bands are much broader and more distinct in the blunt-nosed leopard lizard than in other leopard lizards, and extend from the lateral folds on each side to the middle of the back, where they meet or alternate along the midline of the back. With increasing age, the cross bands may fade and the spots may become smaller and more numerous, particularly in males. Similarly colored bands or rows of transverse spots produce a banded appearance to the tail. Juveniles have blood-red spots on the back that darken with age, becoming brown when sexual maturity is reached, although a few adults retain reddish centers to the spots (USFWS 1998).

Taxonomy

The blunt-nosed leopard lizard was described and named in 1890 by Stejneger as Crotaphytus silus, from a specimen collected in Fresno, California. In 1900, however, Cope considered the blunt-nosed leopard lizard to be a subspecies of the long-nosed leopard lizard (C. wislizenii), and listed it as C. w. silus. Under this arrangement, leopard lizards and collared lizards were placed in the same genus. In 1946, Smith separated the collared from the leopard lizards, placing the latter in the genus Gambelia. The bases for separation were differences in head shape, presence or absence of gular (throat area) folds, and differences in bony plates on the head. The subspecific status of G. w. silus was retained by Smith in 1946. This generic split was not universally agreed upon; the status of the lizards, both generic and specific, remained controversial until 1970, when Montanucci presented a solid argument for specific status based on the study of hybrids between the long-nosed and blunt-nosed leopard lizards. In 1975, Montanucci et al. again separated Gambelia from Crotaphytus, resulting in the name Gambelia silus. Most recently, the specific spelling was changed to sila to properly agree in gender with the genus Gambelia (USFWS 1998; USFWS 2010). The blunt-nosed leopard lizard can be distinguished from the long-nosed leopard lizard by its color pattern; truncated snout; and short, broad, triangular head. The blunt-nosed leopard lizard has dark blotches on the throat instead of the parallel streaks of the long-nosed leopard lizard. Other distinguishing characteristics are a significantly smaller number of maxillary and premaxillary teeth (this may be directly related to the shortened snout) and a smaller variation in the number of femoral pores. In general, blunt-nosed leopard lizards can be distinguished from all other leopard lizards by their retention into adulthood of the primitive color pattern shared by all young leopard lizards (absence of ornamentation around the dorsal spots; retention of wide, distinct cross bands; presence of gular blotches; and fewer spots arranged in longitudinal rows) (USFWS 1998).

Historical Range

The blunt-nosed leopard lizard is endemic to the San Joaquin Valley of central California. It occurred in arid lands throughout much of the San Joaquin Valley and adjacent foothills, ranging from San Joaquin County in the north, to the Tehachapi Mountains in the south, as well as in the Carrizo Plain and Cuyama Valley (USFWS 2010). Except where their range extends into the Carrizo Plain and Cuyama Valley west of the southwestern end of the San Joaquin Valley, the eastern and western boundaries of its distribution is defined by the foothills of the Sierra Nevada and Coast Range Mountains, respectively. The blunt-nosed leopard lizard is not found above 800 meters (m) (2,600 feet [ft.]) in elevation. The blunt-nosed leopard lizard hybridizes with the long-nosed leopard lizard (G. wislizenii) where their ranges meet in Ballinger Canyon and others (Santa Barbara and Ventura counties) in the Cuyama River watershed (USFWS 1998).

Current Range

Due to widespread agricultural development of natural habitat in the San Joaquin Valley, the current distribution of blunt-nosed leopard lizards is restricted to less than 15 percent of its historic range. In the remaining habitat that exists, blunt-nosed leopard lizards occur in alkali sink scrub, saltbush scrub, and native and nonnative grasslands on the Valley floor and in the surrounding foothills areas. Current distribution extends north into Merced County and south into Santa Barbara and Ventura Counties (USFWS 2020). Blunt-nosed leopard lizards have been found near Firebaugh and Madera, Ciervo, Tumey, Panoche Hills, Anticline Ridge, Pleasant Valley, Lone Tree, Sandy Mush Road, Whimesbridge, Horse Pasture, and Kettleman Hills Essential Habitat Areas. Blunt-nosed leopard lizards had been also recently been observed on the Madera Ranch in western Madera County from surveys conducted for the Madera Irrigation District (USFWS 2010).

Distinct Population Segments Defined

No

Critical Habitat Designated

Yes;

Life History

Feeding Narrative

Adult: Blunt-nosed leopard lizards are opportunistic carnivores, insectivores, and omnivores. They feed primarily on insects (mostly grasshoppers, crickets, and moths) and other lizards; they eat some plant material rarely, perhaps unintentionally consumed it with animal prey. They appear to feed opportunistically on animals, eating whatever is available in the size range the can overcome and swallow. Which lizards are eaten is largely determined by the size and behavior of the prey. Lizard species taken as prey include side-blotched lizards (Uta stansburiana), coast horned lizards (Phrynosoma coronatum), California whiptails (Cnemidophorus tigris), and spiny lizards (Sceloporus spp.). Young of its own species also are eaten (USFWS 1998).The species is diurnal and crepuscular during the summer; seasonal above-ground activity is correlated with weather conditions, primarily temperature. Optimal activity occurs when air temperatures are between 23.5 degrees and 40.0 degrees Celsius (°C) (74 and 104 degrees Fahrenheit [°F]) and ground temperatures are between 22 degrees and 36 °C (72 and 97 °F). Because diurnal activity is temperature-dependent, blunt-nosed leopard lizards are most likely to be observed in the morning and late afternoon during the hotter days. Because they have similar diets, interspecific competition probably occurs between the blunt-nosed leopard lizard and California whiptail (Aspidoscelis tigris munda) (USFWS 1998).Before their first winter, young leopard lizards may grow to 88 mm (3.5 in.) in snout-vent length. The species depends on the availability of insects and other small lizards as a food source, and on sparsely vegetated open areas. Potential predators of blunt-nosed leopard lizards include whipsnakes, gopher snakes, glossy snakes (Arizona elegans), western long-nosed snakes (Rhinocheilus lecontei), common king snakes, western rattlesnakes, loggerhead shrikes (Lanius ludovicianus), American kestrels (Falco sparverius), burrowing owls, greater roadrunners (Geococcyx californianus), golden eagles (Aquila chrysaetos), hawks, California ground squirrels, spotted skunks (Spilogale putorius), striped skunks (Mephitis mephitis), American badgers, coyotes, and San Joaquin kit foxes (USFWS 1998).

Reproduction Narrative

Adult: Breeding activity begins within a month of emergence from dormancy and lasts from the end of April through the beginning of June, and in some years to near the end of June. During this period, and for a month or more afterward, the adults often are seen in pairs and frequently occupy the same burrow systems. Male territories may overlap those of several females, and a given male may mate with several females. Copulation may occur as late as June (USFWS 1998).Females typically produce only one clutch of eggs per year, but some may produce three or more under favorable environmental conditions (i.e., greater prey abundance). Females lay two to six eggs, averaging 15.6 by 25.8 mm (0.6 by 1.0 in.), in June and July; their numbers are correlated with the size of the female. In several populations, and during most of the year, males appear to outnumber females by a ratio of 2:1. Hatchling sex rations vary between 1:5:1 and 2.5: 1 (male:female). Blunt-nosed leopard lizards reproduce through oviparity; after about 2 months of incubation in the burrow chamber, young hatch from July through early August, rarely to September, and range in size from 42 to 48 mm (1.7 to 1.9 in.) snout-vent length (USFWS 1998; USFWS 2010).The lizards leave their young to fend for themselves. Sexual maturity is reached from 9 to 21 months, depending on the sex and environmental conditions. Females tend to become sexually mature earlier than males, breeding for the first time after the second dormancy; males usually do not breed until later. Based on estimates, maximum longevity would be 8 to 9 years, with an annual survivorship of about 50 percent. The species requires friable soil substrate to dig nests. and eggs are laid in a chamber either excavated specifically for a nest or already existing in the burrow system (USFWS 1998).

Geographic or Habitat Restraints or Barriers

Adult: Not found above 800 m (2,600 ft.) in elevation. In general, absent from areas of steep slope, dense vegetation, or areas subject to seasonal flooding (USFWS 1998).

Spatial Arrangements of the Population

Adult: Clumped

Environmental Specificity

Adult: Narrow/specialist.

Tolerance Ranges/Thresholds

Adult: High

Site Fidelity

Adult: High

Dependency on Other Individuals or Species for Habitat

Adult: Blunt-nosed leopard lizards use small rodent burrows for shelter from predators and temperature extremes. Blunt-nosed leopard lizards are highly combative in establishing and maintaining territories (USFWS 1998).

Habitat Narrative

Adult: Blunt-nosed leopard lizards are found in open, sparsely vegetated areas of low relief on the San Joaquin Valley floor and in gently sloping alluvial fans of the surrounding foothills that are not more than 800 m (2,600 ft.) in elevation. On the valley floor, they are most commonly found in nonnative grassland and valley sink scrub community. The valley sink scrub is dominated by low, alkali-tolerant shrubs of the family Chenopodiaceae, such as iodine brush, and seepweeds. The soils are saline and alkaline lake bed or playa clays that often form a white salty crust and are occasionally covered by introduced annual grasses. Valley needlegrass grassland, nonnative (annual) grassland, and alkali playa also provide suitable habitat for the lizard on the valley floor. This species also inhabits valley saltbush scrub, a low shrubland with an annual grassland understory, which occurs on the gently sloping alluvial fans of the foothills of the southern San Joaquin Valley and adjacent Carrizo Plain (USFWS 1998).Leopard lizards use small rodent burrows for shelter from predators and temperature extremes. Blunt-nosed leopard lizards are highly combative in establishing and maintaining territories. Leopard lizards require friable soil that can be used for digging burrows (either by rodents or the lizards themselves). In areas of low mammal burrow density, lizards will construct shallow, simple tunnels in earth berms or under rocks. While foraging, immature lizards also take cover under shrubs and rocks. Each lizard uses several burrows without preference, but will avoid those occupied by predators or other leopard lizards. In general, leopard lizards are absent from areas of steep slope or dense vegetation, or areas subject to seasonal flooding (USFWS 1998).

Dispersal/Migration

Motility/Mobility

Adult: Moderate

Migratory vs Non-migratory vs Seasonal Movements

Adult: Nonmigratory

Dispersal

Adult: The average male home range size was 4.24 hectares (ha) (10.48 acres [ac.]), and the average female home range size was 2.02 ha (4.99 ac.). Female home ranges and core areas were overlapped extensively by male ranges at an average of 79.8 percent and 50.3 percent, respectively (USFWS 2010).

Immigration/Emigration

Adult: Uses corridors to disperse between populations (USFWS 2010).

Dispersal/Migration Narrative

Adult: Blunt-nosed leopard lizards are nonmigratory; however, they are mobile when active and will disperse between populations if adequate, open corridors are present. The average male home range size was 4.24 ha (10.48 ac.), and the average female home range size was 2.02 ha (4.99 ac.). Female home ranges and core areas were overlapped extensively by male ranges at an average of 79.8 percent and 50.3 percent, respectively. Female home ranges were found to overlap the ranges of up to four other males, but were not observed to overlap with other females (USFWS 2010). Dispersal characteristics are unknown, but these lizards appear to be capable of making extensive movements. Barriers to dispersal include busy highways or highways with obstructions that lizards rarely if ever cross successfully; major rivers, lakes, ponds, or deep marshes; and urbanized areas dominated by buildings and pavement (NatureServe 2015).

Additional Life History Information

Adult: Female home ranges were found to overlap the ranges of up to four other males, but were not observed to overlap with other females (USFWS 2010).

Population Information and Trends

Population Trends:

Short-term trend: decline of 10 to 30 percent. Long-term Trend: decline of greater than 90 percent (NatureServe 2015). Long-term studies show population instability, especially during years of above-average precipitation (USFWS 1998; USFWS 2010).

Species Trends:

Decreasing (USFWS 2010)

Resiliency:

Under current conditions, there are five populations in high condition, ten populations in moderate condition, and nine populations in low condition. Resilient populations need large areas of contiguous habitat containing the same habitat resources as needed by individuals. Although little is known about patch dynamics, habitat patch size was positively related to probability of occupancy for the species, possibly due to the wide-ranging nature of individuals or the amount of habitat needed to support a resilient population based on home range size and density estimates. The different temporal activity of the varying age classes highlights the importance of prey sources throughout the active period. Appropriate amounts of precipitation are important to support vegetation and prey within the species habitat, although droughts or excess precipitation could actually threaten the species (see discussion in Factors Influencing Viability below). Demographic indicators that might suggest population resiliency are related to effective population size, fecundity, survival, and connectivity. We refer to effective population size according to the definition in a review by Frankham: the size of an idealized population that would give rise to the same variance of gene frequency, or rate of inbreeding, as the actual population under consideration. Briefly, effective population size is calculated using an equation that incorporates heterozygosity, a measure of genetic diversity. Effective population size in wildlife is often much lower than census population size. The ratio between effective population size and census population size varies based on factors such as unequal sex ratios, variance in family size, and population fluctuations. Of these factors, population fluctuations based on limited reproduction in drought years could be a contributing factor for blunt-nosed leopard lizards. Populations need sufficient numbers of juveniles and adults to be able to withstand drought conditions that limit reproduction. Because few adults are seen across more than two years despite expected survivorship of up to 9 years, evidence of breeding is important, as is the ability of females to lay multiple clutches in good years. Connectivity within and between populations is important to maintain (or in some cases, reestablish) gene flow. Although blunt-nosed leopard lizards probably occurred in connected populations (within major subpopulations) throughout the historical range, anthropogenic habitat fragmentation has greatly reduced the potential for gene flow between populations in the current landscape. In isolated populations or genetic clusters, maintaining sufficient numbers of adults in a population to guard against loss of alleles (e.g., from demographic bottlenecks) is important. Attempting to reestablish connectivity between fragmented areas, when possible, will also add to population resilience. (USFWS 2020)

Representation:

Medium. Although populations are largely demographically isolated in the current landscape, establishing dispersal corridors within and between genetic clusters would be an effective conservation strategy to add to the adaptive potential of the species. In particular, reestablishing corridors that were probably historically important for gene exchange would be beneficial. Genomic population structure indicate that sufficient numbers of blunt-nosed leopard lizards survived the extensive development and conversion to agriculture that led to the species' listing as endangered to maintain evidence of primordial structure. Maintaining resilient populations across these genetic clusters is important in preserving this structure and minimizing potential for genetic bottlenecks. In addition to the use of genetic clusters to assess representation, we note the differences in habitat used by the species at both a regional and local level. Habitat types used by different populations range from non-native annual grasslands, grassland mixed with native forbs, saltbrush scrub, and Ephedra steppe. This variation in habitat type highlights the flexibility of the species as well as the potential for local adaptations that contribute towards fitness within populations in these habitats. (USFWS 2020)

Redundancy:

Low. Measures of redundancy for the blunt-nosed leopard lizard include the total number of resilient populations combined with the overall distribution of these populations across the range of the species. Surveys in 2014 after three years of drought identified neonate presence in areas that could be potential climate change refugia for the species. Blunt-nosed leopard lizard neonates in the Panoche Valley region, Carrizo Plain National Monument, Tejon Ranch, and the eastern San Joaquin Valley (e.g., Pixley National Wildlife Refuge) identify these locations as important breeding locations during drought conditions, while surveys in the southwestern part of the range failed to observe neonates. Redundancy for the species relies on having resilient populations in these areas that could be climate change refugia for the species. (USFWS 2020)

Number of Populations:

The species current condition in the SSA was analyzed using 24 populations (USFWS 2020).

Population Size:

2,500 to 10,000 individuals (NatureServe 2015).

Adaptability:

Low

Additional Population-level Information:

The largest and most stable population of blunt-nosed leopard lizards on the valley floor is thought to be at Semitropic Ridge Preserve. However, the number of all lizards at Semitropic Ridge Preserve has been decreasing since 2003 for unknown reasons (USFWS 2010).Blunt-nosed leopard lizards and long nosed leopard lizards (G. wislizenii) from the San Joaquin Valley and Mojave Desert, respectively, hybridize in the upper Cuyama Valley near the Santa Barbara – San Luis Obispo County line (USFWS 2010).

Population Narrative:

Long-term studies show instability in populations of blunt-nosed leopard lizards, especially during years of above-average precipitation. The relative proportions of the three age groups (adult, subadult, and hatchling or young-of-the-year) change through the seasons because young are added to the population only in August or later, and entry into dormancy and differential mortality affects the proportions in age groups above ground. Based on population instability and ongoing modification and conversion of existing habitat for agricultural use, residential or commercial developments, and petroleum and mineral extraction activities, overall species abundance is considered to be decreasing across its range. Overall, the population is estimated to have declined by 10 to 30 percent over the last decade (USFWS 1998; USFWS 2010; NatureServe 2015).The largest and most stable population of blunt-nosed leopard lizards on the valley floor is thought to be at Semitropic Ridge Preserve. However, the number of all lizards at Semitropic Ridge Preserve has been decreasing since 2003 for unknown reasons. The blunt-nosed leopard lizard and long-nosed leopard lizard (G. wislizenii) from the San Joaquin Valley and Mojave Desert, respectively, hybridize in the upper Cuyama Valley near the Santa Barbara – San Luis Obispo County line (USFWS 1998; USFWS 2010; NatureServe 2015). The populations analyzed for condition in the SSA report include two hybrid populations between the blunt-nosed leopard lizard and long-nosed leopard lizard (Gambelia wislizenii). Although protection of hybrid blunt-nosed leopard lizards is not addressed in the SSA report, here we present information relevant to a decision tree for evaluating hybrid protection (Wayne and Shaffer 2016, pp. 2682-2683). Application of the decision tree suggests that these hybrid lizards warrant protection by the Act. This justification is based on mitochondrial DNA (mtDNA) introgression throughout the Cuyama River Valley, observations of morphologically pure blunt-nosed leopard lizards and genome traces (RADseq, SNP and microsatellites) in the lower watershed, and isolation of the watershed populations from either of the parent populations. Further, lizards in the Cuyama River Valley face similar pressures as other bluntnosed leopard lizard populations, reinforcing their need for protection (Westphal in litt. 2019). (USFWS, 2020a)

Threats and Stressors

Stressor: Habitat degradation/loss
Exposure: Loss and modification of habitat due to agricultural and urban development.
Response: Reduction and loss of available food sources and habitat.

Consequence: Population decline and extirpation.
Narrative: Long-term monitoring studies show that blunt-nosed leopard lizard populations drastically decline during consecutive years of drought or above-average precipitation. Above-average precipitation is associated with decreases in survival of the species, while below-average precipitation is associated with decreases in reproduction. Also, blunt-nosed leopard lizard aboveground activity is highly dependent on temperature. Therefore, blunt-nosed leopard lizard population stability and behavior is very sensitive to any changes in precipitation or temperature. Climate models predict for California an overall warming, but vary in their predictions for precipitation. Other scientists predict a decrease in precipitation in the southern San Joaquin. Any significant changes in temperature or precipitation could have drastic effects on blunt-nosed leopard lizard populations. Climate change will likely result in changes in the vegetative communities of blunt-nosed leopard lizard habitat, and potentially increase exotic species. However, there are insufficient data available at this time to predict the effects of climate change on the blunt-nosed leopard lizard (USFWS 2010, USFWS 2020).

Stressor: Oil and gas development
Exposure: Oil and gas exploration.
Response: Vehicle strikes, entombment in burrows, temporary loss or degradation of their habitat, and harassment from noise and vibration.
Consequence: Mortality, injury, population decline, and extirpation.
Narrative: Oil and natural gas exploration activities continue to degrade blunt-nosed leopard lizard habitat in western Kern, Kings, and Fresno counties. The construction of facilities related to oil and natural gas production—such as well pads, wells, storage tanks, sumps, pipelines, and their associated service roads—degrade habitat and cause direct mortality to blunt-nosed leopard lizards. Leakage of oil from pumps and transport pipes, storage facilities, surface mining, and off-road vehicle use also degrade blunt-nosed leopard lizard habitat (USFWS 2010).Disturbances associated with seismic activities are predominantly temporary and are dispersed across large land areas, but nonetheless have the potential to impact blunt-nosed leopard lizards or adversely affect their habitat. It is anticipated that blunt-nosed leopard lizards are likely to be adversely affected by vehicle strikes, entombment in burrows, temporary loss or degradation of their habitat, and harassment from noise and vibration. Some blunt-nosed leopard lizards may escape direct injury if burrows are destroyed, but become displaced into adjacent areas. They may be vulnerable to increased predation, exposure, or stress through disorientation, loss of foraging and food base, or loss of shelter (USFWS 2010).

Stressor: Water banking facilities
Exposure: Urban and rural water facilities.
Response: Vehicle strikes, degradation or loss of suitable habitat, and augmented conversion of native lands to agriculture.
Consequence: Injury, mortality, population decline, and extirpation.
Narrative: The ongoing need to provide and secure water supplies for continued urban and rural use throughout California has increased the demand for new construction of water banking facilities. Water bank projects potentially threaten the blunt-nosed leopard lizard by directly removing habitat (through flooding or the establishment of infrastructure); changing habitat quality (vegetation structure, higher predation, reduced prey, etc.); and increasing the incidence of take through vehicle strikes. Groundwater recharge projects could result in significant effects to this species, beyond the flooding of suitable habitat; these effects would be attributable to the permanent conversion of habitat to water bank infrastructure, including the construction of

access roads, powerlines, pipeline and canal conveyance systems, and numerous water extraction well pads. Water extraction projects are also likely to result in the permanent conversion of habitat to water bank infrastructure, including construction of access roads, powerlines, pipeline and canal conveyance systems, and water extraction well pads. Moreover, they will likely augment the conversion of native lands to agriculture by increasing water supply availability in the southern San Joaquin Valley (USFWS 2010).

Stressor: Solar power development
Exposure: Solar power developments.
Response: Loss, fragmentation, and degradation of habitat; vehicle strikes.
Consequence: Injury, mortality, population decline, and extirpation.
Narrative: Solar power development projects pose potential threats to blunt-nosed leopard lizards and may impact vast amounts of habitat. These projects can destroy, fragment, or impact blunt-nosed leopard lizard habitat by altering landscape topography, vegetation, and drainage patterns; increasing vehicle-strike mortality; and reducing habitat quality by intercepting solar energy that would normally reach the ground surface, affecting ambient air temperatures through habitat shading, and altering soil moisture regimes (USFWS 2010).

Stressor: Predation
Exposure: Wide variety of predators.
Response: Individuals removed from the population due to predation.
Consequence: Unknown
Narrative: The following animals are currently known to prey on blunt-nosed leopard lizards: whip snakes, gopher snakes, glossy snakes (Arizona elegans), western long-nosed snakes (Rhinocheilus lecontei), northern Pacific rattlesnakes (Crotalus viridis oreganus), common king snakes, western rattlesnakes, loggerhead shrikes (Lanius ludovicianus), American kestrels (Falco sparverius), prairie falcons (Falco mexicanus), burrowing owls (Athene cunicularia), greater roadrunners (Geococcyx californianus), golden eagles (Aquila chrysaetos), red-tailed hawks (Buteo jamaicensis), California ground squirrels, spotted skunks (Spilogale putorius), striped skunks (Mephitis mephitis), American badgers (Taxidea taxus), coyotes (Canis latrans), and San Joaquin kit foxes. This list is likely not exhaustive for all incidences of predation that occur across the range of the blunt-nosed leopard lizard, nor has the magnitude of effects derived by predation on population trend and stability been researched at this time. Therefore, it remains unknown as to whether predation is a major threat to the survival and recovery of this species (USFWS 2010).Without mammal burrows, blunt-nosed leopard lizards are more susceptible to predation. The construction of artificial perches (i.e., fence posts) for burrowing owls and other predators increases the risk of predation on blunt-nosed leopard lizards. Additionally, the territorial behavior of blunt-nosed leopard lizard males may expose them to higher rates of predation than if they were secretive (USFWS 2010).

Stressor: Disease
Exposure: See narrative.
Response: See narrative.
Consequence: Unknown
Narrative: There are no known diseases in blunt-nosed leopard lizards, but endoparasites (nematodes) and ectoparasites (mites and harvest mites) have been reported. The overall effect of the parasites on the blunt-nosed leopard lizard is not currently known (USFWS 2010).

Stressor: Regulatory mechanisms
Exposure: Inadequacy of existing regulatory mechanisms.
Response: See narrative.
Consequence: Limited ability to protect the species.
Narrative: There are several state and federal laws and regulations that are pertinent to federally listed species, each of which may contribute in varying degrees to the conservation of federally listed and nonlisted species. These laws, most of which have been enacted in the past 30 to 40 years, have greatly reduced or eliminated the threat of wholesale habitat destruction, although the extent to which they prevent the conversion of natural lands to agriculture is less clear. In summary, the Endangered Species Act (ESA) is the primary federal law that provides protection for this species since its listing as endangered in 1967. Other federal and state regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under ESA. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of ESA (USFWS 2010).

Stressor: Altered vegetation
Exposure: Altered vegetation communities due to grazing, exotic grasses, and wildfire regimes.
Response: Habitat degradation and loss.
Consequence: Reduction in population, and extirpation.
Narrative: The southern San Joaquin Valley of California has been invaded by nonnative plant species since European cattle were brought to the region in the 1500s. Research has reported that the exponential increase in exotic plants has paralleled the increase in human population growth in California. A number of exotic species are frequently observed in blunt-nosed leopard lizard habitat, and have adversely affected the species. Additionally, an overabundance of residual thatch from the previous year's nonnative grass production can have similar adverse effects by shading out or obstructing native seedlings. Vegetation changes include levels of biomass, cover, density, community structure, or soil characteristics. Changes have generally been attributed to the negative effects of off-highway vehicle use, overgrazing by domestic livestock, agriculture, urbanization, construction of roads and utility corridors, air pollution, military training exercises, and other activities. It has also been reported that secondary contributions to degradation include the proliferation of exotic plant species, higher frequency of anthropogenic fire events, and increased nitrogen deposition. Effects of these impacts include alteration or destruction of macro- and micro-vegetation elements, establishment of annual plant communities dominated by exotic species, destruction of soil stabilizers, soil compaction, and increased erosion. Overgrazing may negatively affect blunt-nosed leopard lizards by soil compaction, damaging rodent burrows on which the lizards depend for cover, and stripping away vegetative cover used by both the lizard and its prey. However, the cessation of grazing is likely to be even more detrimental to blunt-nosed leopard lizard due to the dense growth of exotic grasses, as discussed below (USFWS 2010).

Stressor: Vehicles
Exposure: Vehicle-induced mortality (from both roadway traffic and off-road vehicles).
Response: Individuals removed from the population due to being struck or run over by vehicles, harassment, and disruption of foraging and breeding habitat.
Consequence: Injury, mortality, and population decline.
Narrative: Blunt-nosed leopard lizard mortality is known to occur as a result of regular automobile traffic and off-road vehicle use. Roads typically surround and often bisect remaining

fragments of habitat, increasing the risk of mortality by vehicles and further isolating populations. The blunt-nosed leopard lizard's preference for open areas, such as roads, makes them especially vulnerable to mortality from vehicle strikes. During habitat conversion activities, individuals could be killed or injured by operation of heavy equipment (crushing, burial by earthmoving equipment, discing, grading, or mowing) or flooding of habitat. Individuals could be harassed during construction by noise, ground vibrations, compaction of burrows, construction lighting, and disruption of foraging and breeding behavior. Individuals not killed directly by operation of equipment would probably find themselves in suboptimal habitat with a decreased carrying capacity, due to lower availability of foraging and breeding habitat and greater vulnerability to predation. If individuals were displaced from converted lands into nearby native habitat population densities, intraspecific competition and predation pressure would be likely to increase. Animals that lost their fear of humans could become more vulnerable to shooting, poisoning, and roadkill (USFWS 2010).

Stressor: Waterfowl blinds
Exposure: Waterfowl blinds in playas.
Response: Individuals are trapped.
Consequence: Mortality
Narrative: Waterfowl blinds are large drums dug partway into the ground and placed at the edges of playas to conceal hunters. When left uncovered, these structures are pitfall traps for blunt-nosed leopard lizards and other reptiles and small mammals, resulting in their mortality. Hunting clubs should be informed of this problem, and active waterfowl blinds should be covered when not in use; abandoned blinds should be removed or filled in. At this time, however, waterfowl blinds are only being retrofitted with covers, or removed on a case-by-case basis (USFWS 2010).

Stressor: Pesticides
Exposure: Direct and indirect: broad-scale pesticide use and application.
Response: Individuals removed from populations, and reduced availability of food.
Consequence: Population decline.
Narrative: Pesticide use may directly and indirectly affect blunt-nosed leopard lizards. The use of pesticides reduces food available for reproducing blunt-nosed leopard lizards in the spring, and later for hatchlings when they should be storing fat to sustain themselves during their first winter. The most expansive pesticide program within the range of the blunt-nosed leopard lizard is the broad-scale use of malathion. Malathion is a pesticide regulated by the California Department of Food and Agriculture (CDFA), and is typically aerially distributed across much of the blunt-nosed leopard lizard range to reduce impacts of the curly top virus on sugar beet production. The most important effect of malathion on blunt-nosed leopard lizard survival and recovery is the associated reduction in insect prey populations, which can last between 2 and 5 days. Fumigating rodents in burrows may also harm blunt-nosed leopard lizards that shelter in those burrows. U.S. Environmental Protection Agency (U.S. EPA) bulletins governing the use of rodenticides have greatly reduced the risk of significant mortality to blunt-nosed leopard lizard populations. The California Environmental Protection Agency, CDFA, county agricultural departments, California Department of Fish and Game (CDFG), and the U.S. EPA collaborated with USFWS in the development of County Bulletins that both are efficacious and acceptable to land owners. However, the use of rodenticides in blunt-nosed leopard lizard habitat continues to be a potential threat to the species because this effectively reduces the number of rodents available to dig burrows for secondary use by blunt-nosed leopard lizards (USFWS 2010).

Stressor: Climate change
Exposure: Climate change modifying habitats.
Response: Habitat degradation and loss.
Consequence: Unknown
Narrative: Long-term monitoring studies show that blunt-nosed leopard lizard populations drastically decline during consecutive years of drought or above-average precipitation. Also, blunt-nosed leopard lizard aboveground activity is highly dependent on temperature. Therefore, blunt-nosed leopard lizard population stability and behavior is very sensitive to any changes in precipitation or temperature. Climate models predict for California an overall warming, but vary in their predictions for precipitation. Other scientists predict a decrease in precipitation in the southern San Joaquin. Any significant changes in temperature or precipitation could have drastic effects on blunt-nosed leopard lizard populations. Climate change will likely result in changes in the vegetative communities of blunt-nosed leopard lizard habitat, and potentially increase exotic species. However, there are insufficient data available at this time to predict the effects of climate change on the blunt-nosed leopard lizard (USFWS 2010).

Recovery

Reclassification Criteria:
Reclassification to threatened status should be evaluated when the species is protected in specified recovery areas from incompatible uses; management plans have been approved and implemented for recovery areas that include survival of the species as an objective; and population monitoring indicates that the species is stable (USFWS 2010).

Protection of five or more areas, each about 2,427 ha (5,997 ac.) or more of contiguous, occupied habitat: A) Valley floor in Merced or Madera counties; B) Valley floor in Tulare or Kern counties; C) Foothills of the Ciervo-Panoche Natural Area; D) Foothills of western Kern County; and E) Foothills of the Carrizo Plain Natural Area (USFWS 2010).

A management plan approved and implemented for all protected areas identified as important to the continued survival of blunt-nosed leopard lizard that includes survival of the species as an objective (USFWS 2010).

Each protected area has a mean density of two or more blunt-nosed leopard lizards per ha (one per ac.) through one precipitation cycle (USFWS 2010).

Recovery Priority Number: 2C

Delisting Criteria:
Delisting will be considered when, in addition to the criteria for reclassification/downlisting, all of the following conditions have been met:

Three additional areas with about 2,427 ha (5,997 ac.) or more of contiguous, occupied habitat, including: A) One on the valley floor; B) One along the western Valley edge in Kings or Fresno counties; and C) One in the Upper Cuyama Valley of eastern San Luis Obispo and eastern Santa Barbara counties (USFWS 2010).

A management plan has been approved and implemented for all protected areas identified as important to the continued survival of blunt-nosed leopard lizard that includes survival of the species as an objective (USFWS 2010).

Each protected area has a mean density of two or more blunt-nosed leopard lizards per ha (one per ac.) through one precipitation cycle (USFWS 2010).

Recovery Actions:

- Based on the 2010 5-Year Review, the five most important actions that should be taken within the next five years to facilitate the recovery of the blunt-nosed leopard lizard include:
- Facilitate research on the effects of solar projects on blunt-nosed leopard lizard behavior and compatibility (USFWS 2010).
- Establish corridors between existing natural areas in Kern and Tulare counties (i.e., Buena Vista Valley, Elk Hills, Lokern Natural Area, Buttonwillow Ecological Reserve [ER], Semitropic Ridge Preserve, Kern National Wildlife Refuge [NWR], Allensworth ER, and Pixley NWR) to enhance the metapopulation recovery strategy (USFWS 2010).
- Establish a preserve or conservation easement on the natural lands of Madera Ranch in western Madera County. Protect blunt-nosed leopard lizard habitat in the Panoche Valley and in dispersal corridors in western Fresno County—Panoche Creek and Silver Creek, Anticline Ridge, the western rim of Pleasant Valley, Guijarral Hills, and the north end of the Kettleman Hills (USFWS 2010).
- Include the flexibility to alter the dates and stocking rates of livestock in all Resource Management Plans (RMPs) where blunt-nosed leopard lizards have potential to occur—including the Carrizo Plain National Monument RMP, Bakersfield RMP, Caliente RMP, and Hollister RMP—to adaptively manage annual plant production and prevent the dominance of exotic grasses in blunt-nosed leopard lizard habitat. Grazing prescriptions should be tailored to suit the ecological needs specific to the area (USFWS 2010).
- Coordinate with hunting clubs for blunt-nosed leopard lizard protection. Active waterfowl blinds should be covered when not in use, and abandoned blinds should be removed or filled in to prevent entrapment of blunt-nosed leopard lizard and other wildlife (USFWS 2010).
- Other important actions that are important to facilitate blunt-nosed leopard lizard recovery include the following items:
- Kern County--completion of Habitat Conservation Plans (HCPs) and issuance of incidental take permits: a. Complete the Kern County Valley Floor HCP; b. Complete the Chevron Lokern HCP; c. Complete the Oxy of Elk Hills HCP; and d. Encourage Crimson Resource Management to start an HCP or Section 7 formal consultation to protect lands in Buena Vista Valley, NPR-2, and Buena Vista Hills (USFWS 2010).
- Habitat management: a. Assist the Lokern Coordination Team in development of the 44,000-ac. Lokern Natural Area in western Kern County (USFWS 2010).
- Future research and monitoring: a. Continue long-term monitoring of population trends on the valley floor (e.g., Pixley NWR, Lokern Natural Area, Semitropic Ridge Preserve, and Buttonwillow ER) and in the foothills (e.g., Carrizo Plain Natural Area and Elk Hills); b. Census and monitor blunt-nosed leopard lizard populations in western Madera County, central Merced County, and the Ciervo-Panoche Natural Area; c. Study the effects of grazing on blunt-nosed leopard lizard along precipitation gradients in the Elkhorn and Carrizo Plains to determine appropriate grazing prescriptions specific for each area; d. Facilitate research on

the effects of the Central Valley Project Conservation Program and Central Valley Project Improvement Act programs on blunt-nosed leopard lizard recovery, and study the effects of translocation (e.g., Allensworth ER) and agricultural land retirement (e.g., Tranquility and Atwell Island sites) on blunt-nosed leopard lizard; and e. Assess potential effects of malathion on the prey base of the blunt-nosed leopard lizard, and apply findings to the CDFA Curly Top Virus Control Program (USFWS 2010).

- The 1998 Recovery Plan for the species identifies the following specific needed recovery actions:
- 1. Determine appropriate habitat management and compatible land uses for blunt-nosed leopard lizards (USFWS 1998).
- 2. Conduct range-wide surveys of known and potential habitat for presence and abundance of blunt-nosed leopard lizards (USFWS 1998).
- 3. Protect additional habitat for blunt-nosed leopard lizards in key portions of their range; areas of highest priority to target for protection are: a. Natural lands in western Madera County; b. Natural lands in the Panoche Valley area of Silver Creek Ranch, San Benito County; c. Agricultural and natural land between the northern end of the Kettleman Hills and the Guijarral Hills and the Guijarral Hills and Anticline Ridge (the western rim of Pleasant Valley, Fresno County) to restore and protect a corridor of continuous habitat for blunt-nosed leopard lizards and other species without the ability to move through irrigated farmland; d. Natural lands west of Highway 33 and east of the coastal ranges between the Pleasant Valley, Fresno County, on the north and McKittrick Valley, Kern County, on the south; e. Natural lands of the linear, piedmont remnants of their habitat west of Interstate Highway 5 between Pleasant Valley and Panoche Creek, Fresno County; and f. Natural lands in upper Cuyama Valley (USFWS 1998).
- 4. Gather additional data on population responses to environmental variation at representative sites in the blunt-nosed leopard lizard's extant geographic range (USFWS 1998).
- 5. Design and implement a range-wide population monitoring program (USFWS 1998).
- 6. Protect additional habitat for blunt-nosed leopard lizards in the following areas (all are of equal priority): a. Natural and retired agricultural lands around Pixley NWR, Tulare County, with an objective of expanding and connecting the NWR units with each other and with the Allensworth ER; b. Natural land in and around the Elk Hills Naval Petroleum Reserves in California and Lokern Natural Area, with the objective of expanding and connecting existing lands with conservation programs; and c. Natural and retired agricultural lands in the Semitropic Ridge Natural Area, Kern County, with the objective of expanding and connecting existing reserves and refuges (USFWS 1998).
- Other more general recovery actions, identified in the Upland Species of the San Joaquin Valley Recovery Plan, include:
- Develop and implement a regional cooperative program and participation plan (USFWS 1998).
- Protect and secure existing populations (USFWS 1998).
- Determine distributions and population status (USFWS 1998).
- Conduct important research and monitoring (USFWS 1998).
- Maintain and establish linkages in existing natural lands and between islands of habitat on the valley floor and natural lands around the fringe of the valley (USFWS 1998).
- Apply adaptive management in protected areas (USFWS 1998).

- CDFW has developed approved survey methodology to provided a minimum level of protection when projects or maintenance activities are scheduled to occur within potential blunt-nosed leopard lizard habitat. The standardized protocol survey methods require a minimum of 12 days of surveys to assess presence/absence of the species during specific ambient air and ground temperature conditions (CDFW 2004, USFWS 2010).

Conservation Measures and Best Management Practices:

- CDFW has developed approved survey methodology to provided a minimum level of protection when projects or maintenance activities are scheduled to occur within potential blunt-nosed leopard lizard habitat. The standardized protocol survey methods require a minimum of 12 days of surveys to assess presence/absence of the species during specific ambient air and ground temperature conditions (CDFW 2004, USFWS 2010).
- RECOMMENDATIONS FOR FUTURE ACTIONS x Continue demographic and genetic monitoring of the species: Continued surveys for populations with estimated abundance and genetic diversity will assist with assessing status and trends for the species. Additional data on population responses to environmental variation will help to inform land management strategies and restoration to preserve and enhance populations. x Focus on habitat restoration to restore connectivity within and between populations: Reinstating connectivity can increase genetic diversity and enhance representation for the species. Strategic restoration focuses on the restoration of retired lands adjacent to existing natural areas, and as corridors linking protected areas, to create a network of protected lands. Continued efforts towards restoration, and a better understanding of blunt-nosed leopard lizard use of restored areas, will be an important component of recovery for the species. x Encourage conservation and coordination between private landowners and other partners, including the Service: Lack of access for monitoring or conservation-related work has led to challenges in understanding population abundance and resiliency in some areas. Conservation by private landowners and cooperation/coordination between private landowners and other partners should be encouraged. • Continue research of the species: Continued research on blunt-nosed leopard lizard ecology, including research on burrow needs, thermal ecology, prey base, response to pesticides, and causes for population decline, will help address areas of uncertainty in the SSA report. (USFWS, 2020a)

Additional Threshold Information:

-
-

References

32 FR 4001. Native Fish and Wildlife, Endangered Species List. Vol. 32, No. 48. Federal Register 4001. March 11, 1967. Available online at: http://ecos.fws.gov/docs/federal_register/fr18.pdf. Date accessed: March 16, 2016

USFWS (U.S. Fish and Wildlife Service). 1998. Recovery Plan for Upland Species of the San Joaquin Valley, California. U.S. Fish and Wildlife Service. Portland, Oregon. 340 pp. September. Available online at: http://ecos.fws.gov/docs/recovery_plan/980930a.pdf. Date accessed: March 16, 2016

USFWS (U.S. Fish and Wildlife Service). 2010. Blunt-nosed leopard lizard (Gambelia sila) 5-Year Review, Summary and evaluation. U.S. Fish and Wildlife Service. Sacramento, California. 79 pp. February. Available online at: http://ecos.fws.gov/docs/five_year_review/doc3209.pdf. Date accessed: March 16, 2016. 2020. Species Status Assessment for the Blunt-nosed leopard lizard (Gambelia sila) Version 1.0. U.S. Fish and Wildlife Service. Sacramento, California. Available online at: https://ecos.fws.gov/ServCat/DownloadFile/173244

NatureServe. 2015. NatureServe Explorer, An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available online at: http://explorer.natureserve.org/servlet/NatureServe?searchName=Gambelia+silus. Date accessed: March 16, 2016

USFWS (U.S. Fish and Wildlife Service). 2010. Blunt-nosed leopard lizard (Gambelia sila) 5-Year Review, Summary and evaluation. U.S. Fish and Wildlife Service. Sacramento, California. 79 pp. February. Available online at: http://ecos.fws.gov/docs/five_year_review/doc3209.pdf. Date accessed: March 16, 2016. USFWS. 2020. Species Status Assessment for the Blunt-nosed leopard lizard (Gambelia sila) Version 1.0. U.S. Fish and Wildlife Service. Sacramento, California. Available online at: https://ecos.fws.gov/ServCat/DownloadFile/173244

USFWS. 2020. Species Status Assessment for the Blunt-nosed leopard lizard (Gambelia sila) Version 1.0. U.S. Fish and Wildlife Service. Sacramento, California. Available online at: https://ecos.fws.gov/ServCat/DownloadFile/173244

USFWS (U.S. Fish and Wildlife Service). 1998. Recovery Plan for Upland Species of the San Joaquin Valley, California. Portland Fish and Wildlife Office, Portland, California. September 30. Available online at: https://ecos.fws.gov/docs/recovery_plan/980930a.pdf. Date accessed: March 8, 2016

USFWS (U.S. Fish and Wildlife Service). 2010. Blunt-nosed leopard lizard (Gambelia sila) 5-Year Review, Summary and evaluation. U.S. Fish and Wildlife Service. Sacramento, California. 79 pp. February. Available online at: http://ecos.fws.gov/docs/five_year_review/doc3209.pdf. Date accessed: March 16, 2016.

CDFW (California Department of Fish and Wildlife). 2004. Approved Survey Methodology for the Blunt-Nosed Leopard Lizard. May 2004. Revised. Available online at: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=83829. Date accessed: March 27, 2016

CDFW (California Department of Fish and Wildlife). 2019. Approved Survey Methodology for the Blunt-Nosed Leopard Lizard. May 2004 October 2019. Revised. Available online at: Date accessed: March 27, 2016

USFWS. 2020a. 5-YEAR REVIEW Blunt-nosed leopard lizard (Gambelia sila). 5 pp.

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

References

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia.

USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/ecp0/. Accessed April 2016.

U.S. Fish and Wildlife Service. 1990. Gopher Tortoise Recovery Plan. U.S. Fish and Wildlife Service, Jackson, Mississippi. 28 pp.

U.S. Fish and Wildlife Service. 1990. Gopher Tortoise Recovery Plan. U.S. Fish and Wildlife Service, Jackson, Mississippi. 28 pp

USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/speciesProfile/. Accessed April 2016. USFWS. 2021. Species Status Assessment Report for the Gopher Tortoise (Gopherus polyphemus). Southeast Region. Atlanta, GA. 288 pages.

SPECIES ACCOUNT: *Graptemys flavimaculata* (Yellow-blotched map turtle)

Species Taxonomic and Listing Information

Listing Status: Threatened; 1/14/1991; Southeast Region (R4) (USFWS, 2016)

Physical Description

It is a medium-sized aquatic turtle with females attaining a carapace (upper shell) length of a least 2O centimeters (cm) (8 inches) and males occasionally exceeding 12 cm (4 and 3/4 inches). The carapace is olive to light brown. Each costal scute has an irregular bright yellow or orange blotch. Juveniles and adult males have a black spine on the first four vertebral scutes. These spines become smaller and may be lost in adult females (USFWS, ECOS Page).

Taxonomy

Lamb et al. (1994) conducted a mtDNA-based phylogenetic analysis of turtles in the genus Graptemys and discovered three monophyletic lineages: G. pulchra group (including G. pulchra, G. gibbonsi, G. ernsti, and G. barbouri); G. pseudogeographica group (including G. pseudogeographica, G. nigrinoda, G. flavimaculata, G. oculifera, G. versa, G. caglei, and G. ouachitensis); and G. geographica. Overall genetic divergence was relatively low, and G. pseudogeographica, G. nigrinoda, G. flavimaculata, G. oculifera, and G. versa all shared the same mtDNA genotype. There was no evidence of infraspecific variation in any species. Walker and Avise (1998) reviewed these data and suggested that the Graptemys complex has been taxonomically oversplit at the species level.   McDowell (1964) concluded that the genus Graptemys should be included in the genus Malaclemys, but this arrangement generally has been rejected (e.g., see Dobie 1981 for information on osteological differences between the two genera) (NatureServe, 2015).

Current Range

Pascagoula River system, including the Leaf, Chickasawhay, and Escatawpa rivers, southern Mississippi. Apparently most abundant in Pascagoula River between Wade and Vancleave, Mississippi (USFWS 1990). The largest population is in the Pascagoula River in Jackson County, mainly in the Ward Bayou Wildlife Management Area (Horne et al. 2003) (NatureServe, 2015).. Results from two comparable surveys have reported a slight population decline in the Leaf River and Chickasawhay River and recovery of the lower Pascagoula River population to pre-Hurricane Katrina abundances, which exceeds minimum required population size for the Pascagoula River population. The species' range was extended ~30 rkm (18.6 rmi) upstream in the Escatawpa River, indicating potential for expanding populations; however, the status of the Escatawpa population is not known (USFWS, 2022).

Distinct Population Segments Defined

No

Critical Habitat Designated

Yes;

Life History

Feeding Narrative

Adult: Ernst and Barbour (1989) stated that the diet consisted largely of insects and snails, and that captives would eat fish (USFWS, 1993).

Reproduction Narrative

Adult: Nests from mid- to late May through early to mid-August; clutch size 3-9 (mean 4.7); at least some adult females are not reproductive each year; most adult females apparently do not produce more than one clutch per reproductive year (Horne et al. 2003). Males are sexually mature in 3-4 years (or reportedly in second growing season), females later (perhaps at 6-9 years) (Behler and King 1979, USFWS 1990) (NatureServe, 2015).

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 1993)

Environmental Specificity

Adult: Narrow/Specialist (inferred from USFWS, 1993)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1993)

Site Fidelity

Adult: High (inferred from USFWS, 1993)

Habitat Narrative

Adult: The yellow-blotched map turtle is a species of rivers and large creeks. It apparently avoids smaller streams where the surface of the water is shaded by bank vegetation for much of the day. Its preferred habitat has been described as river stretches with moderate currents, abundant basking sites, and sand bars (McCoy and Vogt 1987). The Pascagoula River near Vancleave has numerous accessory channels connecting oxbow lakes to the main river, and the yellow-blotched map turtle occurs in all of these habitats (R.L. Jones, pers. obs. 1991). It is more abundant, however, in the main channel (USFWS, 1993). Clumped spatial arrangement, Narrow environmental specificity, moderate ecological integrity, low tolerance range and high site fidelity are inferred based on habitat specificity, etc. (USFWS, 1993).

Dispersal/Migration

Motility/Mobility

Adult: High (inferred from USFWS, 1993)

Migratory vs Non-migratory vs Seasonal Movements

Adult: Non-migratory (inferred from USFWS, 1993)

Dispersal

Adult: Low (inferred from USFWS, 1993)

Immigration/Emigration

Adult: Unlikely (inferred from USFWS, 1993)

Dispersal/Migration Narrative

Adult: Turtles in a riverine habitat have the ability to move long distances. However, most turtles (with the exception of sea turtles) are non-migratory. Low dispersal of this species and unlikely immigration are inferred based on the species limited number of populations and patchy distribution. (USFWs, 1993; NatureServe, 2015))

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Population Growth Rate:

Declining (NatureServe, 2015)

Number of Populations:

1 - 20 (NatureServe, 2015)

Population Size:

2500 - 100,000 (NatureServe, 2015)

Population Narrative:

NatureServe (2015) notes that both the long-term and short-term population trends are declining and that population densities have declined in recent years. In addition, the number of populations is between 1 and 20 and the number of individuals between 2500 and 100,000. Low resiliency and representation are inferred from the low number of populations (NatureServe, 2015).

Threats and Stressors

Stressor: Sedimentation and Stream Modification
Exposure:
Response:
Consequence:
Narrative: Navigation and flood control projects usually call for removal of logs and snags used by Graptemys flavimaculata for basking. They may also result in the alteration or elimination of sand bars, which are important for nesting. Increased sedimentation and turbidity resulting from both flood control projects and gravel mining can also negatively impact the invertebrate species that are fed upon by the yellow-blotched map turtle. Several channel modification projects in the Pascagoula watershed have been planned, authorized, or completed. A snagging project along almost 4.1 kilometers (2.5 miles) of the Leaf River at Hattiesburg has eliminated basking structure for map turtles and impacted invertebrate prey populations through increased sedimentation and the elimination of the snags and logs that provide habitat for the invertebrates. Seven additional projects on tributaries of the Leaf and Chickasawhay Rivers have either been completed, are being planned, or are under study. In addition, four reservoirs have been built in the Pascagoula watershed and two more are authorized. A gravel mining operation in the Bowie River at its confluence with the Leaf River has caused increased sedimentation downstream in the Leaf River (USFWs, 1993).

Stressor: Commercial Collecting, Wanton Shooting, and Trapping
Exposure:
Response:
Consequence:
Narrative: Yellow-blotched map turtles were collected in the past for the commercial pet trade where they sold for as much as $65 per specimen (Stewart 1989). Illegal collecting for this market probably continues at a reduced level. Some individuals habitually use basking turtles for target practice. Slat baskets and wire traps used illegally to capture catfish have also caught and drowned Graptemys flavimaculata (G. George, pers. comm. 1991).

Stressor: Water Quality Degradation
Exposure:
Response:
Consequence:
Narrative: Water quality degradation from chemical pollution could result in the bioaccumulation of toxic compounds in yellow-blotched map turtles. Although the effects of water quality degradation on Graptemys flavimaculata are not known, moribund turtles, including some Graptemys, afflicted with a subcutaneous ulcerative disease, have been observed in highly polluted segments of the Flint River of Georgia (G. George, pers. comm. 1991). Dodd (1988) speculated that a disease of unknown origin affecting Sternotherus depressus could have involved either an environmental contaminant or a viral infection resulting from an impaired immune system. Stewart (1989) found few turtles less than 4 years old in the lower Pascagoula River near Vancleave. This may reflect limited nesting habitat, high levels of egg and hatchling predation, or the effects of some effluents on the hatchlings or reproductive physiology of the turtle. Although the effects of industrial and municipal effluents (on the turtles of the Pascagoula watershed) are currently unknown, the effects on the invertebrates that most likely constitute the yellow-blotched map turtle’s prey base are well known (Grantham 1962, 1964, 1967). Much of the upper Pascagoula, the Chickasawhay, and the Leaf Rivers have abundant basking sites and wide sandy nesting beaches. The absence or scarcity of Graptemys flavimaculata may indicate that effluents have severely impacted its food resources in these areas.

Recovery

Reclassification Criteria:
Recovery Priority Number: 14

Delisting Criteria:
(1) Evidence of a stable or increasing population in the Leaf, Chickasawhay, and Pascagoula Rivers for a period of at least 15 years. A stable population is defined as one having the reproductive capability to sustain itself without immigration of individuals from other populations. Minimum density estimates from basking counts should average 44 Graptemys flavimaculata [yellow-blotched map turtles] per river kilometer in the Pascagoula River, and at least 22 per river kilometer in the Leaf and Chickasawhay Rivers over the 15-year period. These figures are based on estimates from basking counts conducted by Stewart (1989) in the lower Pascagoula River (USFWS, 2022).

(2) Protection of yellow-blotched map turtle habitat on the entire Pascagoula River and on the lower 129 kilometers (80 miles) of both the Leaf and the Chickasawhay Rivers. The areas to be protected begin, on the Leaf River, at the U.S. 84 bridge in Covington County, and on the Chickasawhay River, in the vicinity of Quitman, Clarke County. Protection is defined as having sufficient control over the watersheds that adverse environmental impacts are unlikely to occur." (USFWS, 2022).

Recovery Actions:

- Determine current status of yellow-blotched map turtle populations in the Leaf, Chickasawhay, and Pascagoula Rivers (USFWS, 1993). Determine status of yellow-blotched map turtle populations in the upper Leaf, upper Chickasawhay, and lower Escatawpa Rivers (USFWs, 1993).
- Determine sex ratios of adults, sizes and ages at maturity, age structure, and growth rates (USFWS, 1993). Investigate reproductive biology by determining clutch size, clutch frequency, nest site selection, time of nesting, incubation period, and clutch survival rate (USFWs, 1993). Investigate daily and seasonal movements (USFWS, 1993). Determine diet by sex and maturity class (USFWs, 1993).
- Examine water quality at selected sample points on the Leaf, Chickasawhay, and Pascagoula Rivers (USFWS, 1993). Characterize habitat conditions in the Chickasawhay, Leaf, and Pascagoula Rivers (USFWS, 1993). Investigate distribution and abundance of major prey species (USFWS, 1993).
- Protect habitat through appropriate conservation measures (USFWS, 1993). Develop a monitoring plan to evaluate yellow-blotched map turtle populations and habitat quality in the conservation areas (USFWS, 1993).
- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Designate specific yellow-blotched map turtle populations in the Leaf, Chickasawhay, and Pascagoula Rivers for regular monitoring of population densities and the habitat that supports them. Focus on populations at sites across the species' range (i.e., Hattiesburg, Leakesville, and Vancleave). 2. Develop a standardized protocol for data collection to determine turtle population density/viability, demography, growth, long-term movements, and longevity. 3. Reassess how best to define "stable" or "increasing" populations and determine if density numbers as currently defined in recovery criteria of the existing recovery plan are appropriate. 4. Conduct an analysis of potential effects to the yellow-blotched map turtle from proposed impoundments of Big Cedar Creek and Little Cedar Creeks, tributaries to the Pascagoula River in George and Jackson Counties, Mississippi. 5. Educate the public about the protected status of the yellow-blotched map turtle in order to reduce the direct take of turtles by shooting and encourage support of limiting public use of nesting sandbars. 6. Study effects of high nest predation on selected populations. 7. Pursue land acquisition of selected river reaches in order to achieve further protection of critical yellow-blotched map turtle populations. 8. Conduct follow-up research to determine if clutch frequency differences between north and south Pascagoula River populations are affecting long-term population viability. 9. Compare water quality data from habitat occupied by stable yellow-blotched map turtle populations with data from habitat occupied by declining populations. 10. Provide training to Law Enforcement personnel on identifying turtles of conservation concern and the threats they face from disturbance and collecting while encouraging enforcement of existing laws and regulations. 11. Develop (when necessary), adopt, and implement Best Management Practices for different land use/land cover categories, including those of timber activities, cropland and pastureland agricultural practices, urbanization, and/or other development

activities in order to prevent runoff and sedimentation of the Pascagoula River drainage. 12. Evaluate the size and status of the Escatawpa yellow-blotched map turtle population and conduct a telemetry study in this region to assess this population's spatial use of coastal environments. 13. Conduct a comparative ecological study of upper Pascagoula River drainage populations since focus has been on work on the lower Pascagoula River population. The availability data on upper Pascagoula River populations indicate there are differences in size and possibly reproductive output that could influence future management decisions. 14. Work with partners to limit threats to the yellow-blotched map turtle such as restricting the size of boats that access occupied river reaches and enforcing speed limits to reduce the negative impacts of excessive boat wakes. 15. Revise the yellow-blotched map turtle recovery plan to more accurately reflect the current data on life history, ecology, and distribution, and revise the recovery criteria (USFWS, 2018).

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES A detailed discussion of recovery actions and criteria are presented in the Recovery Plan (Service 1993). In the course of this status review, new and/or targeted potential recovery activities were identified and are included below. These actions are recommended to support and promote recovery of the yellow-blotched map turtle. Use of a numbered list for these recommendations is for convenient reference only and does not necessarily imply prioritization. Recovery Activities 1. Reassess how best to define "stable" or "increasing" populations and determine if density numbers as currently defined in recovery criteria of the existing recovery plan are appropriate. 2. Revise the yellow-blotched map turtle recovery plan to amend the recovery criteria and more accurately reflect the current data on life history, ecology, and distribution. 3. Develop a Standard Operating Procedure for data collection to determine turtle population density/viability, demography, growth and survivorship rates, long-distance movements, and longevity. 4. Designate populations of yellow-blotched map turtles in the Leaf, Chickasawhay, Escatawpa, and Pascagoula rivers for regular mark-resight monitoring surveys to assess population densities and importance of specific microhabitats. 5. Educate the public about the protected status of the yellow-blotched map turtle to reduce the direct take of turtles by shooting and encourage support of limiting public use of nesting sandbars. 6. Pursue land acquisition of selected river reaches in order to achieve further protection of crucial yellow-blotched map turtle populations. 7. Continue control of invasive plant species on select sandbars to maintain suitable nesting sites, as currently being implemented at Ward Bayou WMA. 8. Provide training to Law Enforcement personnel on identifying turtles of conservation concern and the threats they face from disturbance and collection while encouraging enforcement of existing laws and regulations. 9. Work with partners to limit threats to the yellow-blotched map turtle, such as restricting the size of boats that access occupied river reaches and enforcing speed limits to reduce the negative impacts of excessive boat wakes, primarily in the lower Pascagoula River. Monitoring and Research Activities 1. Continue long-term mark-resight surveys to estimate abundances and trends at the Vancleave, Leakesville, and Hattiesburg populations, as well as other designated monitoring sites throughout the Pascagoula River drainage. 2. Evaluate the size and status of the Escatawpa yellow-blotched map turtle population and conduct a telemetry study in this region to assess this population's spatial use of coastal environments. 3. Assess nest success, predation rates, clutch size, and clutch frequency at representative populations throughout the Pascagoula River and determine the impact of these reproductive parameters and nest predation on recruitment. 4. Conduct research to determine if clutch frequency and size differences between north and south Pascagoula River populations are affecting long-term population viability. 5. Conduct a comparative ecological study (i.e., body size, reproductive output, etc.) of upper Pascagoula River drainage populations. The availability of data indicates there are differences in size and possibly reproductive output along the river continuum that may influence future management decisions (USFWS, 2022).

References

U.S. Fish and Wildlife Service. 1993. Yellow-blotched Map Turtle (Graptemys flavimaculata) Recovery Plan. U.S. Fish and Wildlife Service. Jackson, Mississippi. 18 pp

NatureServe Explorer (2015): An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://explorer.natureserve.org. (Accessed: March 23, 2016) . USFWS. 2022. Yellow-blotched Map Turtle (Graptemys flavimaculata) 5-Year Review: Summary and Evaluation. Southeast Region. Mississippi Ecological Services Field Office. Jackson, Mississippi. 18 pp.

NatureServe Explorer (2015): An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://explorer.natureserve.org. (Accessed: March 23, 2016)

NatureServe Explorer (2015): An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://explorer.natureserve.org. (Accessed: March 28, 2016)

U.S. Fish and Wildlife Service. 1993. Yellow-blotched Map Turtle (Graptemys flavimaculata) Recovery Plan. U.S. Fish and Wildlife Service. Jackson, Mississippi. 18 pp.

U.S. Fish and Wildlife Service. 2018. Yellow-blotched map turtle (Graptemys flavimaculata). 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service. Southeast Region. Mississippi Ecological Services Field Office. Jackson, Mississippi. 33 pp.

USFWS. 2022. Yellow-blotched Map Turtle (Graptemys flavimaculata) 5-Year Review: Summary and Evaluation. Southeast Region. Mississippi Ecological Services Field Office. Jackson, Mississippi. 18 pp.

SPECIES ACCOUNT: *Graptemys oculifera* (Ringed map turtle)

Species Taxonomic and Listing Information

Listing Status: Threatened; 12/23/1986; Southeast Region (R4) (USFWS, 2016)

Physical Description

The ringed sawback turtle is a small turtle (adults 7.5 – 22 cm) having a yellow ring bordered inside and outside with dark olive-brown on each shield of the upper shell or carapace and a yellow undershell or plastron. The head has a large yellow spot behind the eye, two yellow stripes from the orbit backwards and characteristic yellow stripe covering the whole lower jaw (Cagle 1953). Males are considerably smaller than females (USFWS, 1993).

Taxonomy

Lamb et al. (1994) conducted a mtDNA-based phylogenetic analysis of turtles in the genus Graptemys and discovered three monophyletic lineages: G. pulchra group (including G. pulchra, G. gibbonsi, G. ernsti, and G. barbouri); G. pseudogeographica group (including G. pseudogeographica, G. nigrinoda, G. flavimaculata, G. oculifera, G. versa, G. caglei, and G. ouachitensis); and G. geographica. Overall genetic divergence was relatively low, and G. pseudogeographica, G. nigrinoda, G. flavimaculata, G. oculifera, and G. versa all shared the same mtDNA genotype. There was no evidence of infraspecific variation in any species. Walker and Avise (1998) reviewed these data and suggested that the Graptemys complex has been taxonomically oversplit at the species level. See McCoy and Vogt (1988) for taxonomic history of G. oculifera. McDowell (1964) concluded that the genus Graptemys should be included in the genus Malaclemys, but this arrangement generally has been rejected (e.g., see Dobie 1981 for information on osteological differences between the two genera) (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

The ringed map turtle is restricted to the Pearl River and its major tributaries in Mississippi and Louisiana. It is not found in the tidally influenced section of the lower West Pearl River. This species' distribution has been monitored periodically since the late 1970's (McCoy and Vogt 1980; Jones and Hartfield 1995; Dickerson and Reine 1996; Lindeman 1998; Shively 1999; Jones 2009; LDWF 2009). The spatial distribution of the ringed map turtle throughout the Pearl River drainage has not changed based on these studies (USFWS, 2010).

Distinct Population Segments Defined

No

Critical Habitat Designated

No;

Life History

Feeding Narrative

Adult: Insects, mollusks, and crustaceans are primary foods. Feeds mostly on aquatic insects picked off submerged logs (Shively, no date) (NatureServe, 2015). Fish and carrion may be an occasional and opportunistic food source (USFWS, 1988).

Reproduction Narrative

Adult: Lays clutch of about 3-4 eggs (4-8 according to Matthews and Moseley 1990) in June and probably another later. Males are sexually mature in about 3-5 years (Kofron 1991, Amphibia-Reptilia 12:161-168). Jones and Hartfield (1995) determined that males matured at 3.5 years, females at 10-16 years. In addition (NatureServe, 2015). Mating likely occurs in late spring and early summer and egg incubation under natural conditions required an average of 63-65 days (USFWS, 1988).

Spatial Arrangements of the Population

Adult: Clumped (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Most abundant in streams with moderate to fast current, numerous basking logs, nearby sand and gravel bars, and channel wide enough to allow sun to reach basking logs from 1000-1600 hrs (McCoy and Vogt 1980, Dickerson and Reine 1996). Not in tributaries or tidal areas. Requires high water quality to support main food sources. Eggs are laid in nests dug in sandy beaches or gravel bars (NatureServe, 2015). Spatial arrangement of the population, ecological integrity of the population and tolerance ranges are inferred based on specific habitat requirements.

Dispersal/Migration

Motility/Mobility

Adult: High (inferred from NatureServe, 2015)

Migratory vs Non-migratory vs Seasonal Movements

Adult: Non-migratory (inferred from NatureServe, 2015)

Immigration/Emigration

Adult: Unlikely (inferred from NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Map turtles live in riverine-riparian systems and associated floodplain lakes, ponds, and sloughs. Often they nest on sandy banks or sand bars but sometimes up to about 100 m from water. Long-distance overland movements appear to be rare, but available information indicates that map turtles may move considerable distances along riverine corridors. Hence, separation distance for suitable habitat refers to riverine corridors whereas separation distance for unsuitable habitat refers to upland habitat. For Graptemys flavimaculata in Mississippi, mean male home range area was 1.12 ha, mean home range length was 1.9 km (range 0.2-5.9 km); these values for females were 5.75 ha and 1.6 km (range 0.2-2.8 km) (difference is not significant) (Jones 1996). For Graptemys geographica, daily and annual movements varied greatly among individuals in a river in central Pennsylvania (up to several thousand meters in a few days, or virtually no movement over several years; Pluto and Bellis 1988). Range length was 0.2-6.1 km (mean 2.1 km) for 46 males and 0-5.3 km (mean 1.2 km) for 14 females. Juveniles moved 4.7-5.3 km upstream or downstream over 1-2 seasons. In Vermont, range length for 6 adult females (with sonic tracking tags) was 1.5-8.0 km along the Lamoille River; some individuals moved downstream to Lake Champlain (2.7 km) and along the lakeshore as much as 2.2 km before returning to the hibernaculum (Graham et al. 2000). Graptemys pseudogeographica sometimes may move more than 1 mile (1.6 km) upstream in less than a month (Vogt 1981). These data suggest that a large separation distance of at least 20 stream km is appropriate for distinguishing different occurrences along a stretch of suitable habitat (NatureServe, 2015). High mobility is inferred based on similar species mobility. Non-migratory is inferred based on its highly specific habitat needs as is unlikely immigration (inferred from NatureServe, 2015).

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Population Growth Rate:

Stable (NatureServe, 2015)

Number of Populations:

5 (USFWS, 2020)

Population Size:

10,000-100,000 (NatureServe, 2015)

Population Narrative:

NatureServe (2015) notes that there are 1-5 populations with 10,000-100,000 individuals. NatureServe also notes that the short-term trend is relatively stable while the long-term trend is a decline of 30-50%. Resiliency, representation and redudancy are inferred based on specific habitat needs and the low number of populations.

Threats and Stressors

Stressor: Impoundments (USFWS, 2010).
Exposure:
Response:
Consequence: Loss of basking and nesting areas (USFWS, 2010)
Narrative: The ringed map turtle requires structures (logs, snags, etc.) on which it can safely bask protected from predation and suitable nesting habitat (large, high, sandbars adjacent to the river). These habitat features are threatened by habitat modification conducted for flood control (impoundments) and navigation, as well as sand and gravel mining (USFWS, 2010).

Stressor: River channel erosion (USFWS, 2010).
Exposure:
Response:

Consequence: Loss of basking sites (USFWS, 2010)
Narrative: River channel erosion is continuing to change the structural dynamics of the river system, especially south of the reservoir at Jackson, Mississippi. Sand and gravel mining and the removal of logs in streams are contributing to river channel erosion in Louisiana (Shively 1999). Erosion results in a wider and shallower channel due to stream bank destabilization. River channel erosion may have negative effects on the basking sites of the ringed map turtle (USFWS, 2010).

Stressor: Human collection (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Shooting of basking turtles for recreation and collecting turtles for commercial purposes posed a threat to the ringed map turtle at the time of listing. Direct take by humans is a continuing threat. Shooting of ringed map turtles has been documented since the time of listing the species (Shively 1999). There is evidence that collecting for commercial purposes also continues (USFWS, 2010).

Stressor: Predation (USFWS, 2010)
Exposure:
Response:
Consequence: Nests destroyed
Narrative: Approximately 86 percent of the ringed map turtle nests in the study were attacked by vertebrates and approximately 24 percent of the remaining eggs were destroyed by invertebrates (Jones 2006). Armadillos (Dasypus novemcinctus) and raccoons (Procyon lotor) were the most frequent nest predators; fish crows (Corvus ossifragus) were also significant nest predators (Jones 2006). Invertebrate predators included Solenopsis molesta, a native species of fire ant, and larvae of the dipteran Tripanurga importuna, a sarcophagid fly (Jones 2006) (USFWS, 2010).

Stressor: Pollutants (USFWs, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The Mississippi and Louisiana Departments of Environmental Quality have developed lists of impaired waters in their respective states to satisfy the requirements with respect to Section 303(d) of the CWA (Louisiana Department of Environmental Quality 2004; Mississippi Department of Environmental Quality 2006). Reaches of the Pearl River in both states, and reaches of the Bogue Chitto River in Louisiana, are included on these lists. Also identified on the lists are the pollutants causing or potentially causing impairment of designated uses. Pollutants include excessive nutrients, organic enrichment/low dissolved oxygen, pesticides, sedimentation/siltation, mercury and other toxics, and pathogens. One of these pollutants, increased siltation, has been implicated in the decline of diversity in the fish fauna of the Bogue Chitto River in Louisiana where the ringed map turtle also occurs (Stewart et al. 2005) (USFWS, 2010).

Stressor: Boating/Recreation (USFWS, 2010)
Exposure:

Response:
Consequence: limiting nesting habitat/low fecundity
Narrative: Boating and other recreational uses of the Pearl and Bogue Chitto Rivers during the summer months are threats to basking turtles and turtle nests. Ringed map turtles usually abandon their perches when people boat or float by their sites and may not re-emerge to bask for up to an hour (Shively 1999). A study has been conducted on the impacts of boating on basking by the yellow-blotched map turtle in the Pascagoula River. In order to reduce the negative impacts to basking behavior that they documented, the authors of the study suggested that a limit be enacted on the size of boats allowed to access the river (Selman et al. 2010). Graptemys species bask with a greater frequency than many other turtles (Lindemann 1998). Alterations in basking frequencies may affect the general health of ringed map turtles, and because basking may be integral to the maturation of eggs, lower basking frequencies may reduce the ability of females to mature their clutches of eggs. In addition, large numbers of people party and camp on the same open, high sandbars favored by nesting ringed map turtles (Jones 2006). This use of sandbars by humans can limit turtle nesting habitat when turtles avoid these otherwise quality nesting sites (Jones 2006) or nests may be destroyed inadvertently by human activities on the sandbars (USFWS, 2010).

Recovery

Delisting Criteria:
Protection of a total of 150 miles of the turtle's habitat in two reaches of the Pearl River, There must be a minimum of 30 miles in either reach with the total protected area totaling 150 river miles (USFWS, 1988).

Evidence of a stable or increasing population over at least a ten year period on these two Pearl River reaches (USFWS, 1988).

An established, continuing plan of periodic monitoring of population trends and habitat to ensure a stable population in these river reaches (USFWS, 1988).

Recovery Actions:
- Characterize physical parameters of habitat (USFWS, 1988).
- Determine reproductive requirements (USFWS, 1988).
- Determine food sources (USFWS, 1988).
- Determine population structure (USFWS, 1988).
- Determine activity periods and behavior (USFWS, 1988).
- From the information gathered, determine and protect at least two river reaches critical to maintaining a stable population (USFWS, 1988).

References

U.S. Fish and Wildlfe. 1988. A Recovery Plan for the Ringed Sawback Turtle. Graptemys oculifera. U.S. Fish and Wildlife Service, Atlanta, Georgia. 28 pp

NatureServe Explorer (2015): An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://explorer.natureserve.org. (Accessed: March 22, 2016)

U.S. Fish and Wildlfe. 2010. Ringed map turtle (Graptemys oculifera) 5-Year Review: Summary and Evaluation U.S. Fish and Wildlfie Service Southeast Region Mississippi Ecological Services Field Office Jackson, Mississippi.

NatureServe Explorer (2015): An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://explorer.natureserve.org. (Accessed: March 22, 2016). USFWS. 2020. Ringed map turtle (Graptemys oculifera). 5-Year Review: Summary and Evaluation. 33 pp.

SPECIES ACCOUNT: *Macrochelys suwanniensis* (Suwannee alligator snapping turtle)

Species Taxonomic and Listing Information

Physical Description

The genus Macrochelys includes the largest freshwater turtle species in size found in North America. These turtles are highly aquatic and somewhat secretive. They are primitive in appearance and are characterized by a large head with an acute, sharp squamosal projection, long tail, and an upper jaw with a strongly hooked beak. They have muscular legs and webbed toes with long, pointed claws. M. suwanniensis's carapace has a large, lunate caudal notch and three keels with posterior elevations on the scutes. Their dark brown carapace often has algal growth that adds to their camouflage. Their hinge-less plastron is significantly smaller than their carapace and is narrow and cross-shaped with a long, narrow bridge. The plastron is grayishbrown in color in adults; in juveniles it may be somewhat mottled with small whitish blotches. Their eyes are positioned on the side of the head and are surrounded by small, fleshy, pointed projections. Numerous epidermal projections are also present on the side of the head, chin and neck (Ernst and Lovich 2009, p. 138-139). Hatchlings look very similar to adults (Ernst and Lovich 2009, p. 146) (USFWS, 2020).

Taxonomy

M. suwanniensis is a member of the Family Chelydridae, Order Testudinata, Class Reptilia. This family includes two genera Macrochelys and Chelydra. Chelydra is represented by three species occurring within the Americas: 1) common snapping turtle found in North America (C. serpentina), 2) South American snapping turtle (C. acutirostris), and 3) Central American snapping turtle (C. rossignonii). The nomenclatural history of the M. suwanniensis is complex and continues to evolve. The species was first described in 1789 as Testudo planitia but it was placed in the genus Macrochelys by Gray in 1856. Although subsequent authors referred to the genus as Macrochelys, this placement was refuted and it was believed the alligator snapping turtle should be included in the genus Macroclemys (Smith 1955 p 16, Lovich 1993, p. 562.1-562.2). In 1995, Webb demonstrated that the genus Macrochelys has precedence over Macroclemys, and the Society for the Study of Amphibians and Reptiles adopted this revision in 2000 (Crother et al. 2000, p. 79). Accordingly, for the purpose of this report, we will use Macrochelys as the genus name (USFWS, 2020).

Historical Range

Historical distribution records of M. suwanniensis are sparse, with most trapping occurring near easy access areas to streams and rivers (i.e. road crossings and boat launches). Allen and Neill (1950, p. 1) report M. suwanniensis in Florida from the Suwannee River in Dixie and Levy counties and from the Santa Fe River in Suwannee, Bradford, and Alachua counties. Reports of M. suwanniensis occurring in the Ocklawaha River, Marion Co. may be escapees from the Ross Allen's Reptile Institute at Silver Springs, Marion Co. (Moler, 1996, p.1; Florida Fish and Wildlife Conservation Commission, 2015, p.2), but a voucher specimen exists from 1916 (AMNH 8287). Reports of M. suwanniensis from the Okefenokee Swamp have occurred since 1912 (Allen and Neill, 1950, p.1; De Sola and Abrams, 1933, p. 11; Wright and Funkhouser, 1915, p. 111, and S. Aicher 2020, personal communication), but they are sparse and M. suwanniensis have not been found in any of the other waterways draining from the swamp (USFWS, 2020).

Current Range

Research indicates the current occupied bodies of waters are (Figure 2): Florida – Suwannee River, Hunter Creek, Rocky Creek, Santa Fe River, New River, Ichetucknee River, Cow Creek, Alapaha River, and Withlacoochee River (Enge et al. 2014, p. 19 – 20; Johnston et al. 2015b, p. 75 – 76; Jackson and Thomas 2018, entire; K. Enge 2020, pers. communication) Georgia – Suwannee River, Withlacoochee River, Alapaha River, Alapahoochee River, Willacoochee River, Little River, Tom's Creek, Warrior Creek, Okapilco Creek, and Piscola Creek (Stevenson, 2019, entire) (USFWS, 2020).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food Source

Adult: opportunistic/generalist feeder (USFWS, 2020)

Food/Nutrient Narrative

Adult: Macrochelys suwanniensis is an opportunistic scavenger and consumes a variety of foods. Fish comprise a significant portion of the M. suwanniensis diet; however, crayfish, mollusks, smaller turtles, insects, snakes, birds, and vegetation (including acorns) have also been reported (Elsey 2006, p. 448-489; Elbers and Moll 2011, entire). M. suwanniensis also consume fruit of the common persimmon (Diospyros virginiana) and may function as a seed disperser (Johnston et al. 2015a, p. 59–60; Elbers 2010, entire). Macrochelys spp. are the only turtle species that have a predatory lure (a small, worm-like appendage on the tongue. Both adults and juveniles use this lure to attract fish into striking range. The lure is white or pale pink in juveniles and mottled or gray in adults (Ernst and Lovich 2009, p. 147). Ernst and Lovich (2009, p.148) describe four phases to feeding behavior: waiting, luring, attack, and handling. Success in each phase increases with experience (USFWS, 2020).

Reproductive Strategy

Adult: Oviparity (USFWS, 2020)

Lifespan

Adult: In captivity, a male alligator snapping turtle caught as an adult lived for over 70 years at the Philadelphia Zoo and was estimated to be 80 years old when it died (Ernst and Lovich 2009, p. 147) (USFWS, 2020).

Breeding Season

Adult: Mating takes place underwater (Ernst and Lovich 2009, p. 144) and has been observed in captive M. temminckii from February to October (USFWS, 2020).

Other Reproductive Information

Adult: In the absence of studies on verified unharvested populations, natural demographics and population structure are unknown for Macrochelys spp. (Folt et al. 2016, p. 29). Apparent survival of adult males and females have been estimated at 0.98 for males and 0.95 for females in Georgia (Folt et al. 2016, p. 28) and 0.96 for males and 0.88 for females in Arkansas (Howey and Dinkelacker 2013, p. 6). Population modeling of M. suwanniensis in the Suwannee River in Florida indicated an estimated survival of 0.98 for adults (T. Thomas, 2020. pers. communication). Rate of survivorship of juveniles is estimated at only about 5%, with most mortality occurring in the first two years of life (Ernst and Lovich 2009, p. 150). In a non-declining population of Macrochelys spp., however, juvenile apparent survival has been reported as 0.86 (Folt et al. 2016, p. 27). Mean generation time for Macrochelys spp. has been reported at 31.2 years (range = 28.6-34.0 years, 95% CI) based on a demographic study in Georgia (Folt et al. 2016, p. 27). In captivity, a male alligator snapping turtle caught as an adult lived for over 70 years at the Philadelphia Zoo and was estimated to be 80 years old when it died (Ernst and Lovich 2009, p. 147). Growth data are also scarce for wild Macrochelys spp. Annual weight growth rate has been reported as 5.3% in males and 5.2% in females, with males growing significantly faster than females (Ernst and Lovich 2009, p. 146). Growth is rapid until maturity (11-13 years of age), slowing after 15 years of age (Dobie 1971, p. 654). Immature M. suwanniensis in the Santa Fe River were observed to grow 13.3–19.1 mm carapace length (CL) / year, suggesting approximately 20 years of growth are required to attain sexual maturity (Johnston et al. 2012, p. 474). Growth rate is influenced by many factors including availability of food and prevailing water temperatures; the length of the animal's activity period seems to be one of the most significant factors. A sexual size dimorphism index estimate of -1.8 by mass (36 kg male/20 kg female) and -1.2 by length (53.8 cm CL male/44.6 cm CL female) has been calculated, favoring males (Ewert et al. 2006, p. 63). Estimates of this index for M. suwanniensis in the Santa Fe River (Johnston et al. 2015b, p. 78) are -2.0 by mass (34 kg male/17 kg female) and -1.2 by length (53.1 cm CL male/42.4 cm CL female). M. temminckii adult 1.4:1 sex ratio favoring males has been reported in northwestern Arkansas (Trauth et al. 1998, p. 242), whereas a 1:1 ratio was documented in southeastern Louisiana (Boundy and Kennedy 2006, p. 6) and Georgia (Jensen and Birkhead 2003, p. 29). An even adult sex ratio is consistent with predictions for long-lived turtles (Folt et al. 2016, p. 29). An adult sex ratio of 1:2 (male: female) has been reported in Alabama (Folt and Godwin 2013, p. 214) and in Florida (Ewert and Jackson 1994, p. iii). A higher male to female sex ratio has also been reported for M. suwanniensis in Florida (3.5:1; Enge et al. 2014, p. 32 and Thomas 2013, p. 41), but it varied among sections of the river. A 1:1 adult sex ratio was reported for M. suwanniensis in the Santa Fe River (Johnston et al. 2015b, p. 76). A ratio of Macrochelys spp. juveniles to adults has been reported at 1:4 in Georgia (Jensen and Birkhead 2003, p. 29). Another study in Georgia reported a greater proportion of adults than juveniles, which is a structure consistent with a general prediction for long-lived turtles like Macrochelys spp. (Folt et al. 2016, p. 29). A 1:3 ratio was reported for M. suwanniensis in the Santa Fe River (Johnston et al. 2015b, p. 78–79) (USFWS, 2020).

Reproduction Narrative

Adult: Macrochelys spp. sexual maturity is achieved in 11-21 years for males and 13-21 years for females (Figure 3) (Ernst and Lovich 2009, p. 144; Reed et al. 2002, p. 4). Mating takes place underwater (Ernst and Lovich 2009, p. 144) and has been observed in captive M. temminckii from February to October. Females ovulate in spring and apparently breed yearly, though poor foraging success may cause females to skip a breeding year. No more than one clutch per year per female has been observed in the wild, and they exhibit lower reproductive output than the smaller common snapping turtle, C. serpentina; Reed et al. 2002, p. 4). Clutch sizes for Macrochelys spp. have been reported from across the species' range (9-61 eggs, with a mean of 27.8 (Ernst and Lovich 2009, p. 145). Two clutches of M. suwanniensis in the wild had 43 and 47 eggs (Jackson and Thomas 2018, entire), and six clutches from captive M. suwanniensis had a mean of 24.5 eggs (range 16–44) (Allen and Neill 1950, entire). Reproductive output also varies substantially among females but generally is positively correlated with body size (Reed et al. 2002. p. 4). Larger (older) females probably produce more eggs than recently matured females (Ernst and Lovich 2009, p. 145). Eggs are spherical, chalky white (nearly opaque), pliable, with diameters ranging from 0.9 to 2 inches (22.9 to 51.8 mm) and weighing 16.9 to 36.1 grams (0.6 to 1.3 ounces; Ernst and Lovich 2009, p. 145). Nesting females usually represent the only adult life stage to venture short distances onto land (Ernst and Lovich 2009, p. 141). It is speculated that females leave the water during the late night or early dawn hours and complete nesting during the day (Ernst and Lovich 2009, p. 145). Macrochelys spp. do not appear to be particularly selective regarding nest site conditions, though one researcher in Florida did observe a conspicuous absence of nests in low forested areas with leaf litter and root mats and on open sand bars (Ewert 1976, p. 151). Macrochelys spp. nests have been observed approximately 8-656 feet (2.5 to 200 meters) landward from the nearest water (Ernst and Lovich 2009, p. 145). Internal temperature of nests in Florida were between 66 and 80° Fahrenheit (F) (19-26.5° Celsius [C]) initially and increased to 79-98° F (26.1-36.5° C) as the season progressed, with an incubation time of 105-110 days (Ernst and Lovich 2009, p. 145). This species also exhibits TSD-2 (temperature-dependent sex-determination, Type 2), where more males are produced at intermediate incubation temperatures and more females are produced at the two extremes (Ernst and Lovich 2009, p. 16, 146). Most nesting begins in April and extends through May (Ernst and Lovich 2009, p. 145; Carr et al. 2010, p. 87). Holcomb and Carr (2011a, p. 225) estimated the incubation period was 98-121 days and estimated emergence of hatchlings was 0.5 – 22 days (USFWS, 2020).

Habitat Type

Adult: Both (Aquatic and Terrestrial) (USFWS, 2020)

Habitat Vegetation or Surface Water Classification

Adult: Macrochelys spp. are generally found in deeper water of large rivers and their major tributaries; however, they are also found in a wide variety of habitats, including small streams, springs, bayous, canals, swamps, lakes, reservoirs, ponds, floodplains during flooding, and oxbows (a lake that forms when a meander of a river is cut off; Ernst and Lovich 2009, p. 141) (USFWS, 2020).

Habitat Narrative

Egg: Eggs: Temperatures 66 to 80° F (19 to 26.5° C) increasing to 79 to 98° F (26.1 to 36.5° C) as the season progresses Eggs: Near shore areas (8 to 656 feet [2.5 to 200 meters] landward from the nearest water) with appropriate temperatures (see above) (USFWS, 2020)

Juvenile: Hatchlings: Shallow water and increased canopy cover Juveniles: Found in small streams with mud and gravel bottoms (e.g., 8-18 inches [20-46 centimeters] deep) Hatchling/Juvenile/Adult: Primarily fish, but also crayfish, mollusks, smaller turtles, insects, nutria, snakes, birds, and vegetation (including acorns) Juvenile/Adult: Deeper water (usually large rivers, major tributaries, bayous, canals, swamps, lakes, ponds, and oxbows); shallower water in early summer and deeper depths in late summer and mid-winter (which may be a thermoregulatory shift) Juvenile/Adult: Structure (e.g., tree root masses, stumps, submerged trees, etc.); may include a high percentage of canopy cover; or within stream banks (USFWS, 2020)

Adult: Macrochelys spp. are generally found in deeper water of large rivers and their major tributaries; however, they are also found in a wide variety of habitats, including small streams, springs, bayous, canals, swamps, lakes, reservoirs, ponds, floodplains during flooding, and oxbows (a lake that forms when a meander of a river is cut off; Ernst and Lovich 2009, p. 141). Macrochelys spp. more often select structure (e.g., tree root masses, stumps, submerged trees, etc.) than open water and may select sites with a high percentage of canopy cover (Howey and Dinkelacker 2009, p. 589). In Florida, habitat has been identified as floodplain swamp forests comprised of bald cypress and tupelos associated with close association with numerous flooded channels (Ewert et al. 2006, p.61, Ewert and Jackson 1994, p. 3 – 4). The Suwannee River basin waterways are fed by artesian springs and spring runs which may provide additional thermally stable refugia or optimal habitat (Enge et al. 2014, p. 39). In the upper Suwannee River, M. suwanniensis were observed or trapped in Hunter and Rocky creeks, which are small, blackwater tributaries (K. Enge 2020, pers. communications). The amount of suitable habitat available to M. suwanniensis within its range and a description of how those numbers were derived is presented in Appendix E. Barnacles have been observed growing on shells of M. temminckii. in Dog River, about 2 mi upriver from Mobile Bay, which implies a certain level of salt tolerance (Jackson and Ross 1971, p. 188). In addition, M. temminckii have been documented on Tyndall Air Force Base (Lane and Mitchell 1997, p. 6) where the individual(s) would have needed to transverse through brackish water from a river to the coastal military installation (USFWS, 2020).

Dispersal/Migration

Population Information and Trends

Resiliency:

Population Needs (Resiliency) Individual needs at larger scale: For populations to persist, they need adequate conditions for breeding, feeding, sheltering, and survival as described above at a larger scale. Habitat Quantity and Connectivity: Areas of connected habitat must be sufficient in size to support enough M. suwanniensis to allow individuals to find mates while avoiding inbreeding Abundance: Populations need enough individuals to provide resilience against stochastic demographic and environmental variation (USFWS, 2020)

Representation:

The concept of representation and representative units do not apply to this single basin endemic species (USFWS, 2020).

Redundancy:

This species exists as one population and thus redundancy is not applicable to our analysis of the species (USFWS, 2020).

Number of Populations:

Three (USFWS, 2020)

Population Size:

~ 2,000 (USFWS, 2022)

Population Narrative:

For the population to persist, the needs of individuals (Table 3) must be met at a larger scale. These include nesting habitat (appropriate structure and substrate, location near water, temperature); habitat for hatchlings, juveniles, and adults (e.g., smaller streams for juveniles, deeper water for adults, with structure for refugia); food; and mates. These individual needs must be met within an area of habitat that can support enough M. suwanniensis to survive, find mates, and reproduce while avoiding inbreeding depression. To persist, the population must be robust in size not only to avoid genetic effects from inbreeding, but also to provide resilience against stochastic demographic and environmental events. Later in this chapter we describe how we used abundance estimates and information about threats affecting abundances to describe resilience of the single population of M. suwanniensis (USFWS, 2020). Currently, abundance is estimated at 2,000 individuals with approximately 76.2 turtles per 1,000 hectares (2,471 acres) of open water (USFWS, 2022)

Threats and Stressors

Stressor: Incidental hooking (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative: Incidental hooking, which is estimated to affect 50% of the species' range in the Suwannee River basin (average bounds between 30 and 75%, average 55% expert confidence that the true value lies within their specified bounds). The expert elicitation data indicates a reduction of juvenile and adult survival by 6 – 9%. This is similar to Steen and Robinson's (2017) determination of 3 – 11% chance of mortality from hook ingestion (USFWS, 2020).

Stressor: Illegal harvest (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative: Illegal harvest, which is estimated to affect 32.5% of the species' range in the Suwannee River basin (average bounds between 20.5% and 55%, with an average expert confidence of 55% that the true value lies within their specified bounds) (USFWS, 2020)

Stressor: Nest predation (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative: Nest predation, which is estimated to affect 7% of the species' range in the Suwannee River basin (60% confidence that the true value lies between 5 and 10%) (USFWS, 2020)

Stressor: Habitat alteration (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative: Habitat alteration from woody debris removal was also identified as a threat to individuals in this population. Florida allows deadhead logging with the proper permits from Florida Department of Environmental Protection and Georgia is not currently processing permits

(USFWS, 2020)

Recovery

Conservation Measures and Best Management Practices:

- Species Protections The FWC directs staff to evaluate all species listed as Threatened or Species of Special Concern as of September 1, 2010, as required by rule 68A-27.0012 Florida Administrative Code. Since the original 2010 biological status review, Thomas et al. (2014, p. entire) described 2 new species of alligator snapping turtle based upon genetic and skeletal differences, necessitating new biological status reviews of all species. During the 2017 biological assessment, it was determined by the biological review group that M. suwanniensis was distinct and warranted listing as Threatened based upon IUCN Red List criteria (FWC, 2017. p.3). This determination lead to the development of a Species Action Plan (SAP) for Florida's alligator snapping turtles. The SAP includes all Macrochelys spp. due to their similarity in appearance, vulnerability to deliberate human take, incidental take with fishing gear, pollution, riverine habitat alteration, and nest predation (FWC 2018, p.iii). The objectives of the SAP include: Habitat Conservation and Management, Population Management, Monitoring and Research, Rule and Permitting Intent, Law Enforcement, Incentives and Influencing, Education and Outreach, and Coordination with Other Entities (FWC 2018, p.10-27). Georgia listed Macrochelys spp. as threatened in 1992. In the State's Wildlife Action Plan, the Department of Natural Resources indicate they intend to conduct genetic, taxonomic and reproductive studies of high priority species (GDNR 2015, p. D-5) (USFWS, 2020).
- State and Federal Stream Protections (Deadhead Logging): Deadhead logging is the removal of submerged cut timber from a river or creek bed and banks. The structural diversity and channel stabilization created by instream woody debris has been found to be essential in providing habitat for spawning and rearing aquatic species (Bilby 1984, p. 609 and Bisson et al. 1987, p. 143). Wallace and Benke (1984, p. 1651) reported that snag or woody habitat was the major stable substrate in southeastern Coastal Plain sandy-bottom streams and a site of high invertebrate diversity and productivity. Wood enhances the ability of a river or stream to utilize the nutrient and energy inputs and has a major influence on the hydrodynamic behavior of the river (Wallace and Benke 1984, p. 1643). Florida allows deadhead logging with the proper permits from Florida Department of Environmental Protection and Georgia is not currently processing permits (USFWS, 2020).
- State and Federal Stream Protections (Buffers & Permits): A buffer is a strip of trees, plants, or grass along a stream or wetland that naturally filters out dirt and pollution from rain water runoff before it enters rivers, streams, wetlands, and marshes (Southern Environmental Law Center 2014, p. 2). Loss of riparian vegetation and canopy cover result in increased solar radiation, elevation of stream temperatures, loss of allochthonous (organic material originating from outside the channel) food material, and removal of submerged root systems that provide habitat for fish and macroinvertebrates (Allan 2004, p. 266-267). The Georgia Erosion and Sediment Control Act restricts disturbance and trimming of vegetation within a 25 foot (7.62 m) buffer adjacent to creeks, streams, rivers, saltwater marshes and most lakes and ponds and the Georgia Planning Act require some local governments to adopt a 100 foot (30.48 m) buffer. The Florida Surface Water Improvement and Management plan addresses statewide non-point source pollution impacts to waterbodies on a landscape scale and partners' federal, state, local government, and the private sector to restore damaged ecosystems and prevents pollution from storm water runoff. Section 401 of the federal Clean Water Act (CWA) requires that an applicant for a federal license or permit provide a certification that any discharges from the facility will not degrade water quality or violate water-quality standards, including state-established water quality standard requirements. Section 404 of the CWA establishes programs to regulate the discharge of dredged and fill material into waters of

the United States. Permits to fill wetlands, to install, replace, or remove culverts, to install, repair, replace, or remove bridges, or to re-align streams or water features are issued by the U.S. Army Corps of Engineers under Nationwide, Regional General Permits or Individual Permits include: Nationwide Permits are for “minor” impacts to streams and wetlands, and do not require an intense review process. These impacts usually include stream impacts under 150 feet (45.72 m), and wetland fill projects up to 0.50 acres (0.2 hectare). Mitigation is usually provided for the same type of wetland or stream impacted, and is usually at a 2:1 ratio to offset losses and make the “no net loss” closer to reality. Regional General Permits are for various specific types of impacts that are common to a particular region; these permits will vary based on location in a certain region/state. Individual permits are for the larger, higher impact and more complex projects. These require a complex permit process with multi-agency input and involvement. Impacts in these types of permits are reviewed individually and the compensatory mitigation chosen may vary depending on project and types of impacts.

- Permits to fill wetlands, to install, replace, or remove culverts, to install, repair, replace, or remove bridges, or to re-align streams or water features are issued by the U.S. Army Corps of Engineers under Nationwide, Regional General Permits or Individual Permits include: Nationwide Permits are for “minor” impacts to streams and wetlands, and do not require an intense review process. These impacts usually include stream impacts under 150 feet (45.72 m), and wetland fill projects up to 0.50 acres (0.2 hectare). Mitigation is usually provided for the same type of wetland or stream impacted, and is usually at a 2:1 ratio to offset losses and make the “no net loss” closer to reality. Regional General Permits are for various specific types of impacts that are common to a particular region; these permits will vary based on location in a certain region/state. Individual permits are for the larger, higher impact and more complex projects. These require a complex permit process with multi-agency input and involvement. Impacts in these types of permits are reviewed individually and the compensatory mitigation chosen may vary depending on project and types of impacts. (USFWS, 2020)

Additional Threshold Information:

-
-

References

U.S. Fish and Wildlife Service. 2020. Species status assessment report for the Suwannee alligator snapping turtle (Macrochelys suwanniensis), Version 1.1. July 2020. Atlanta, GA.

U.S. Fish and Wildlife Service. 2020. Species status assessment report for the Suwannee alligator snapping turtle (Macrochelys suwanniensis), Version 1.1. July 2020. Atlanta, GA. USFWS. 2022. Species status assessment report for the Suwannee alligator snapping turtle (Macrochelys suwanniensis), Version 1.2. May 2022. Atlanta, GA.

USFWS. 2020. Species status assessment report for the Suwannee alligator snapping turtle (Macrochelys suwanniensis), Version 1.1. July 2020. Atlanta, GA.

SPECIES ACCOUNT: *Macroclemys temmincki* (Alligator snapping turtle)

Species Taxonomic and Listing Information

Listing Status: Proposed Endangered

Physical Description

The alligator snapping turtle (Figure 2) is the largest species of freshwater turtle in North America and is highly aquatic and somewhat secretive. They are primitive in appearance and are characterized by a large head, long tail, and an upper jaw with a strongly hooked beak. They have muscular legs and webbed toes with long, pointed claws. They have three keels with posterior elevations on the scutes of the carapace, which is dark brown and often has algal growth that adds to the alligator snapping turtle's camouflage. Their hinge-less plastron is significantly smaller than their carapace and is narrow and cross-shaped with a long, narrow bridge. The plastron is greyish-brown in color in adults; in juveniles it may be somewhat mottled with small whitish blotches. Their eyes are positioned on the side of the head and are surrounded by small, fleshy, pointed projections. Numerous epidermal projections are also present on the side of the head, chin and neck (Ernst and Lovich 2009, p. 138-139). Hatchlings look very similar to adults (Ernst and Lovich 2009, p. 146). (USFWS, 2021)

Taxonomy

The alligator snapping turtle (Macrochelys temminckii) is a member of the Family Chelydridae, Order Testudinata, Class Reptilia. This family includes two genera Macrochelys and Chelydra. Chelydra is represented by three species occurring within the Americas: 1) common snapping turtle found in North America (Chelydra serpentina), 2) South American snapping turtle (Chelydra acutirostris), and 3) Central American snapping turtle (Chelydra rossignonii). The nomenclatural history of the alligator snapping turtle is complex and continues to evolve. The species was first described in 1789 as Testudo planitia but it was placed in the genus Macrochelys by Gray in 1856. Although subsequent authors referred to the genus as Macrochelys, this placement was refuted and it was believed the alligator snapping turtle should be included in the genus Macroclemys (Smith 1955, p. 16). In 1995, Webb demonstrated that the genus Macrochelys has precedence over Macroclemys, and the Society for the Study of Amphibians and Reptiles adopted this revision in 2000 (Crother et al. 2000, p. 79). Accordingly, for the purpose of this report, we will use Macrochelys as the genus name. (USFWS, 2021)

Historical Range

Alligator snapping turtles were historically found in 14 states: Alabama, Arkansas, Florida, Georgia, Illinois, Indiana, Kansas, Kentucky, Louisiana, Missouri, Mississippi, Oklahoma, Tennessee, and Texas. Currently, the species is known to occur in Alabama, Arkansas, Florida, Georgia, Illinois, Kentucky, Louisiana, Missouri, Mississippi, Oklahoma, Tennessee, and Texas. This list includes all historically occupied states except for Indiana and Kansas, where persistence is unknown. In Indiana, alligator snapping turtle eDNA has been collected in the water, but presence has not been confirmed with trapping. In Kansas, the species has not been detected since a 1991 record in Montgomery County (See Section 4.5.3 for methods of collecting this information). (USFWS, 2021)

Current Range

Due to the aquatic nature of the species, the alligator snapping turtle is confined to river systems that flow into the Gulf of Mexico, extending from the Suwannee River in Florida to the San Antonio River in Texas (Figure 3). In the Mississippi Alluvial Valley, it is widely distributed from the Gulf to as far north as Indiana, Illinois, southeastern Kansas and eastern Oklahoma. In the Gulf Coastal Plain, its range extends from eastern Texas to southern Georgia and northern Florida. Historically, the alligator snapping turtle occurred over eastern Oklahoma, but today it is believed to be restricted to the east central and southeastern portion of the state (Ernst and Lovich 2009, p. 139). In addition, in a letter dated August 25, 2018, the State of Iowa Department of Natural Resources (DNR) informed the Service that the alligator snapping turtle record that was once considered evidence that this species existed in Iowa is no longer considered credible; and, a committee of regional herpetological experts recommended removing the species from the list of Iowa Species of Greatest Conservation Need. The species was removed from Iowa DNR's Wildlife Action Plan in 2015 (Iowa Department of Natural Resources 2015). (USFWS, 2021)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Food/Nutrient Narrative

Adult: Alligator snapping turtles are opportunistic scavengers and consume a variety of foods. Fish comprise a significant portion of the alligator snapping turtle diet; however, crayfish, mollusks, smaller turtles, insects, nutria, snakes, birds, and vegetation (including acorns) have also been reported (Elsey 2006, p. 448-489). The alligator snapping turtle is the only turtle species that has a predatory lure (a small, worm-like appendage on the tongue; Figure 4). Both adults and juveniles use this lure to attract fish into striking range. The lure is white or pale pink in juveniles and mottled or gray in adults (Ernst and Lovich 2009, p. 147). (USFWS, 2021)

Reproductive Strategy

Adult: Oviparity (USFWS, 2021)

Breeding Season

Adult: year round

Reproduction Narrative

Adult: Sexual maturity is achieved in 11-21 years for males and 13-21 years for females (Figure 5) (Tucker and Sloan 1997, p. 589). Mating takes place and has been observed in captive alligator snapping turtles from February to October, but geographic variation among wild populations is not well understood (Reed et al. 2002, p. 4). Females ovulate in spring and apparently breed yearly, though poor foraging success may cause females to skip a breeding year. No more than one clutch per year per female has been observed in the wild, and they exhibit lower reproductive output than the smaller common snapping turtle (Chelydra serpentina; Reed et al. 2002, p. 4). Clutch sizes have been reported from across the species' range (9-61 eggs, with a mean of 27.8) (Ernst and Lovich 2009, p. 145); Georgia has reported as few as 9 eggs (Ernst and Lovich 2009, p. 145; Reed et al. 2002, p. 4); Florida reported 17- 52 (mean 35.1; Ernst and Lovich 2009, p. 145); and Louisiana reported a mean of 23.8 eggs (Dobie 1971). Reproductive output also varies substantially among females but generally is positively correlated with body size (Reed et al., p. 4). Larger (older) females probably produce more eggs than recently matured females (Ernst and Lovich 2009, p. 145). (USFWS, 2021)

Habitat Type

Adult: Both (Aquatic and Terrestrial)

Habitat Narrative

Adult: Alligator snapping turtles are generally found in deeper water of large rivers and their major tributaries; however, they are also found in a wide variety of habitats, including small streams, bayous, canals, swamps, lakes, reservoirs, ponds, and oxbows (a lake that forms when a meander of a river is cut off). Alligator snapping turtles more often select structure (e.g., tree root masses, stumps, submerged trees, etc.) than open water and may select sites with a high percentage of canopy cover (Howey and Dinkelacker 2009, p. 589; Harrel et al. 2006, p.66; Carr et al. 2007, p.37; Carr et al. 2010, p.43). The amount of suitable alligator snapping turtle within its range and a description of how those numbers were derived is presented in Appendix A. (USFWS, 2021)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Dispersal is likely among the juvenile age class, but mark recapture studies cannot account for permanent immigration so reincorporating these factors into the projection model seemed sensible (USFWS, 2021)

Population Information and Trends

Population Trends:

Declining (USFWS, 2021)

Population Size:

68,154 and 1,436,825 (USFWS, 2021)

Population Narrative:

The range-wide abundance of alligator snapping turtles is estimated to be between 68,154 and 1,436,825 (a range of 1,368,671; Table ES2). This enormous range in the estimated abundance illustrates the very high degree of uncertainty that exists in abundances at local sites and the ability to extrapolate local abundance estimates to a much broader spatial scale. Within these bounds, the most likely estimate of range-wide alligator snapping turtle abundance is 361,213 turtles, with 55% of these occurring in the Alabama Analysis Unit. (USFWS, 2021)

Threats and Stressors

Stressor: Hook Ingestion (USFWS, 2021)
Exposure:
Response:
Consequence:

Narrative:

Stressor: Nest Predation (USFWS, 2021)
Exposure:
Response:
Consequence:
Narrative:

Stressor: Adult Harvest (legal and illegal) (USFWS, 2021)
Exposure:
Response:
Consequence:
Narrative:

Recovery

Conservation Measures and Best Management Practices:

-

Additional Threshold Information:

-
-

References

USFWS. 2021. Species status assessment report for the alligator snapping turtle (Macrochelys temminckii), Version 1.2. March 2021. Atlanta, GA.

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

Adult: 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).

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).
-

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:

-
-

References

62 FR 64306. Endangered and Threatened Wildlife and Plants, Determination of Endangered Status for the Callippe Silverspot Butterfly and the Behren's Silverspot Butterfly and Threatened Status for the Alameda Whipsnake. Final Rule. Vol. 62, No. 234. Federal Register 64306. December 5, 1997. Rules and Regulations. Available online at: http://ecos.fws.gov/docs/federal_register/fr3183.pdf. Date accessed: February 12, 2016

71 FR 58175. Endangered and Threatened Wildlife and Plants, Proposed Determination of Critical Habitat for the Alameda Whipsnake (Masticophis lateralis euryxanthus). October 2, 2006. Available online at: https://www.gpo.gov/fdsys/pkg/FR-2006-10-02/html/E6-15797.htm Riemer, William J. 1954. A New Subspecies of the Snake Masticophis lateralis from California. Museum of Vertebrate Zoology, University of California, Berkeley 4, California

USFWS (U.S. Fish and Wildlife Service). 2002. Draft Recovery Plan for Chaparral and Scrub Community Species East of San Francisco Bay, California. Bell, Heather. Trap, Kirsten. McKinney, Tony. Holzman, Steve. U.S. Fish and Wildlife Service Portland Fish and Wildlife Office. November. Available online at: http://ecos.fws.gov/docs/recovery_plan/030407.pdf. Date accessed: February 12, 2016

USFWS (U.S. Fish and Wildlife Service). 2005. Species Account, Alameda Whipsnake, Masticophis lateralis euryxanthus. U.S. Fish and Wildlife Serve, Sacramento Fish and Wildlife Office. Sacramento, California. Available online at: http://www.fws.gov/sacramento/es_species/Accounts/Amphibians-Reptiles/Documents/alameda_whipsnake.pdf . Date accessed: March 4, 2016

USFWS (U.S. Fish and Wildlife Service). 2011. Alameda Whipsnake (Masticophis lateralis euryxanthus) 5-Year Review, Summary and Evaluation. U.S. Fish and Wildlife Serve, Sacramento Fish and Wildlife Office. Sacramento, California. September. Available online at: http://ecos.fws.gov/docs/five_year_review/doc3886.pdf. Date accessed: February 12, 2016.

U.S. Fish ans Wildlife Service. 2006. Endangered and Threatened Wildlife and Plants, Designation of Critical Habitat for the Alameda Whipsnake. Final rule. 71 FR 58176 - 58231 (October 2, 2006)

U.S. Fish ans Wildlife Service. 2000. Endangered and Threatened Wildlife and Plants, Final Determination of Critical Habitat for the Alameda Whipsnake (Masticophis lateralis euryxanthus). Final rule. 65 FR 58933 -58962 (October 3, 2000).

65 FR 12155 12167. Endangered and Threatened Wildlife and Plants, Proposed Determination of Critical Habitat for the Alameda Whipsnake (Masticophis lateralis euryxanthus). Proposed Rule. Vol. 65, No. 46. Federal Register 12155. March 8, 2000. Rules and Regulations. Available online at: http://www.fws.gov/policy/library/2000/00fr12155.pdf. Date accessed: February 12, 2016

NatureServe. 2015. NatureServe Explorer, An online encyclopedia of life [web application]. Masticophis lateralis euryxanthus. Alameda Whipsnake. Available online at: http://explorer.natureserve.org/servlet/NatureServe?searchName=masticophis+lateralis+euryxanthus. Date accessed: February 12, 2016

USFWS (U.S. Fish and Wildlife Service). 2005. Species Account, Alameda Whipsnake, Masticophis lateralis euryxanthus. U.S. Fish and Wildlife Serve, Sacramento Fish and Wildlife Office. Sacramento, California. Available online at: http://www.fws.gov/sacramento/es_species/Accounts/Amphibians-Reptiles/Documents/alameda_whipsnake.pdf. Date accessed: March 4, 2016

NatureServe. 2015. NatureServe Explorer, An online encyclopedia of life [web application]. Coluber (Masticophis) lateralis euryxanthus. Alameda whipsnake. Available online at: http://explorer.natureserve.org/servlet/NatureServe?searchName=Masticophis+lateralis+euryxanthus. Date accessed: February 12, 2016

USFWS (U.S. Fish and Wildlife Service). 2011. Alameda Whipsnake (Masticophis lateralis euryxanthus) 5-Year Review, Summary and Evaluation. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office. Sacramento, California. September 8. Available online at: http://ecos.fws.gov/docs/five_year_review/doc3886.pdf. Date accessed: February 12, 2016.

USFWS (U.S. Fish and Wildlife Service). 2011. Alameda Whipsnake (Masticophis lateralis euryxanthus) 5-Year Review, Summary and Evaluation. U.S. Fish and Wildlife Serve, Sacramento Fish and Wildlife Office. Sacramento, California. September. Available online at: http://ecos.fws.gov/docs/five_year_review/doc3886.pdf. Date accessed: February 12, 2015

USFWS. 2020. 5-YEAR REVIEW Alameda Whipsnake (Masticophis lateralis euryxanthus). 17pp.

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).

References

USFWS 2016. Status of the Species and Critical Habitat: Neoseps reynoldsi (Sand Skink). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia.

USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/ecp0/. Accessed April 2016.

USFWS 2016. Status of the Species and Critical Habitat: Neoseps reynoldsi (Sand Skink). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016. USFWS. 2023. Sand Skink (Neoseps reynoldsi) 5-Year Status Review: Summary and Evaluation. Southeast Region. Florida Ecological Services Field Office. Gainesville, Florida. 15 pp.

USFWS. 2023. Sand Skink (Neoseps reynoldsi) 5-Year Status Review: Summary and Evaluation. Southeast Region. Florida Ecological Services Field Office. Gainesville, Florida. 15 pp.

SPECIES ACCOUNT: *Nerodia clarkii taeniata* (Atlantic salt marsh snake)

Species Taxonomic and Listing Information

Commonly-used Acronym: ASMS

Listing Status: Threatened; 12/29/1977; Southeast Region (R4) (USFWS, 2016)

Physical Description

The Atlantic salt marsh snake (N. c. taeniata) is a partially striped salt marsh snake that reaches a maximum length of at least 82 cm (32 in.), although it is typically less than 65 cm (26 in.) in length. The pattern consists of a gray to pale olive background with black to dark brown stripes anteriorly, the stripes breaking up into rows of spots posteriorly. The extent of the striping is variable, but most individuals from the coastal marshes of Volusia County are striped on at least the anterior 30 percent of the body. The venter is black with a central row of large cream to yellowish spots. As in the case of the dorsal striping, this ventral pattern is best developed anteriorly and tends to break down posteriorly. The red pigmentation characteristic of mangrove water snakes is conspicuously lacking in Atlantic salt marsh snakes from the vicinity of Edgewater, Volusia County, and northward (i.e., the area from which the form was described) (USFWS, 1993).

Taxonomy

The Atlantic salt marsh snake has a complex taxonomic history, having been known under various combinations of generic, specific, and subspecific names. The North American water snakes were long included within the genus Natrix, but Rossman and Eberle (1977) restricted that genus to Eurasia and erected the genus Nerodia to include many of the North American species previously included within Natrix. At the species level, the salt marsh snakes have at various times been treated as a separate species or as subspecies of two related freshwater species. Both the Gulf salt marsh snake (Nerodia clarkii clarkii) and the mangrove water snake (N. clarkii compressicauda) were initially described as separate species. Based at least partly on reports of hybrids between N. c. clarkii and the freshwater broad-banded water snake (N. fasciata confluens), Clay (1938) reduced the salt marsh snakes to subspecies of N. sipedon, a name that at the time applied to all of the banded water snakes of eastern North America. Subsequently, Conant (1963) elevated the subspecies of N. fasciata to species status to include the three salt marsh snakes and the three southern freshwater subspecies: N. f. fasciata, N. f. confluens, and N. f. pictiventris. At the time that the Atlantic salt marsh snake was listed as threatened, it was regarded as a subspecies of the southern water snake, N. fasciata (fide Conant, 1963). More recently, Lawson et al. (1991) conducted an extensive electrophoretic analysis of the N. fasciata - N. clarkii complex, including specimens from three hybrid swarms. They found no genetic introgression between the salt marsh snakes and the adjacent freshwater snakes and concluded that the salt marsh snakes warrant recognition as a separate species, N. clarkii. Hence, the appropriate name for the Atlantic salt marsh snake is now Nerodia clarkii taeniata. At the subspecific level, the Atlantic salt marsh snake has alternately been treated as a separate subspecies or synonymized with the mangrove water snake. It was described by Cope (1895) as Natrix compressicauda taeniata, a subspecies of the mangrove water snake. It was synonymized with N. compressicauda by Barbour and Noble (1915), but then resurrected as a separate subspecies by Carr and Goin (1942). Dunson (1979) again proposed that taeniata should be relegated to synonymy with compressicauda, although he never examined any specimens of taeniata nor visited the taeniata localities. The form that the U.S. Fish and Wildlife Service (Service) listed as threatened is the Atlantic salt marsh snake, Nerodia fasciata taeniata (now N. clarkii taeniata). The taxonomic status of the Atlantic salt marsh snake will remain controversial until a thorough, rigorous systematic assessment is conducted. The Endangered Species Act (Act) defines the term species as including ". . . any subspecies of fish or wildlife or plants, and any distinct population or segment of any species or vertebrate fish or wildlife which interbreeds when mature." Final resolution of the taxonomic status of the Atlantic salt marsh snake will provide further insight into proper management but continued protection under the Act appears justified whether it remains a distinct subspecies or a distinct population. Regardless of its taxonomic status, the Atlantic salt marsh snake is a relict of historical and/or ecological processes unique to Florida and should be preserved (Kochman 1992) (USFWS, 1993).

Historical Range

Restricted to the salt marshes of Volusia, Brevard, and possibly Indian River Counties, Florida (USFWS, 1993).

Current Range

Recent studies restrict the range of this subspecies to coastal areas of Volusia County, Florida, USA (NatureServe, 2015).

Distinct Population Segments Defined

No

Critical Habitat Designated

No;

Life History

Feeding Narrative

Adult: It feeds primarily on small fish, but it readily takes frogs when available (USFWS, 1993).

Reproduction Narrative

Adult: This species is ovoviviparous. Captive individuals have given birth to 3 to 9 young from August to October (Kochman 1992) (USFWS, 1993).

Spatial Arrangements of the Population

Adult: Clumped (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Narrow/Specialist (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Atlantic salt marsh snakes are restricted to brackish, tidal marshes. They most often have been found in association with saltwort flats and salt grass-bordered tidal creeks. It is not known if they occur in the adjacent black needlerush (Juncus roemerianus) habitat. Atlantic salt marsh snake use of marsh habitats may be limited by water level; with extreme fluctuations making the marsh too hydric or xeric (G. Goode pers. comm.). When inactive or pursued, they frequently retreat into one of the numerous fiddler crab (Uca pugilator) burrows that riddle the edge of the marsh and the banks of the tidal creeks (Carr and Goin 1942, Kochman 1992, P. Moler pers. obs.) (USFWS, 1993) (USFWS, 1993). Clumped spatial arrangement of the population, narrow environmental specificity, high ecological integrity of the community, low tolerance ranges and high site fidelity are inferred based on the specific habitat needs of this species along with the few and somewhat isolated populations that are known to occur.

Dispersal/Migration

Motility/Mobility

Adult: High (inferred from NatureServe, 2015)

Migratory vs Non-migratory vs Seasonal Movements

Adult: Non-migratory (inferred from NatureServe, 2015)

Dispersal

Adult: Low (inferred from NatureServe, 2015)

Immigration/Emigration

Adult: Unlikely (inferred from NatureServe, 2015)

Dispersal/Migration Narrative

Adult: High mobility is based on the fact that most snakes are highly mobile. Non-migratory is inferred based on the species habitat description and known populations. Low dispersal is inferred based on specific habitat needs as is unlikely immigration/emigration (inferred from NatureServe, 2015).

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Number of Populations:

1 to 20 (NatureServe, 2015)

Population Size:

250 - 100,000 (NatureServe, 2015)

Population Narrative:

Population size is just an estimate as no substantial data exist (NatureServe, 2015). Population and range have declined because of habitat alteration. The U.S. Fish and Wildlife Service (USFWS 1990) categorized the status as "declining." (NatureServe, 2015). Low resiliency, representation and redundancy are inferred based on low number of populations and specific habitat requirements.

Threats and Stressors

Stressor: Habitat loss (USFWS, 2008).
Exposure:
Response:
Consequence: Decrease in populations
Narrative: The loss of saltwater habitat from upland construction projects appears to have slowed in the 1990s (Service 1999), a preliminary GIS analysis of Volusia County salt marshes suggests that 2,000 acres (14%) have been lost since listing (L. White, USFWS, pers. comm., 2007). On a positive note, most of the habitat where ASMS likely occurs is publicly owned and/or sovereign submerged lands of the State of Florida, and thus future development in these area will likely be limited. There is also a major initiative underway in Volusia County to restore all the disturbed salt marsh systems that were dragline ditched during the 1950s and 1960s. To date over 1,000 acres of disturbed salt marsh areas within the Mosquito Lagoon and Tomoka River/Bulow Creek areas have been restored and enhanced and are likely improving habitat conditions for the ASMS. Overall, however, loss and modification off salt marsh habitat continues to be a threat to ASMS recovery. An overall assessment of rates of loss, restoration, conversion, fragmentation, and creation of salt marsh wetlands of value to ASMS has not been compiled, it is not known whether the current habitat base will support a population at levels sufficient to prevent extinction long term (USFWS, 2008).

Recovery

Delisting Criteria:
If there is no evidence of significant genetic introgression (genetic exchange limited to a very narrow hybrid zone) from the Florida banded water snake (Nerodia fasciata pictiventris) into adjacent populations of the Atlantic salt marsh snake (Nerodia clarkia taeniata) (USFWS, 1993, USFWS, 2008).

Maintain adequate habitat protection and maintain habitat loss at or below current levels for the next 5 years (USFWS, 1993, USFWS, 2008).

Establish self-sustaining populations of 100-200 adult snakes at each of 10 secure, discrete sites dispersed throughout Volusia County. These numerical goals are subject to revision as more information becomes available on the biology of the Atlantic salt marsh snake (USFWS, 1993, USFWS, 2008).

These populations should be monitored for at least 5 years before considering delisting. If delisted, these populations will continue to be periodically monitored as required by the Act (USFWS, 1993, USFWS, 2008).

Recovery Actions:
- Conduct basic ecological studies of the Atlantic salt marsh snake population in the northern Indian River Lagoon of Volusia County (USFWS, 1993).
- Determine and map distribution of the Atlantic salt marsh snake (USFWS, 1993; USFWS, 2008).

- Identify and implement appropriate habitat protection measures (USFWS, 1993; USFWS, 2008).
- Conduct a taxonomic assessment of the salt marsh snakes in Volusia. Brevard. And Indian River Counties (USFWS, 1993; USFWS, 2008).
- Determine relative abundance within occupied habitats, identify the most important populations and habitat, and develop a population censusing technique (USFWS, 1993; USFWS, 2008).
- Determine extent of genetic introgression at one or more sites where hybridization with N. fasciata is known to have occurred (USFWS, 1993; USFWS, 2008).
- Development of a contingency plan (USFWS, 1993).
- Disseminate information about Atlantic salt marsh snakes (USFWS, 1993).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Complete (including peer-review) the taxonomic and genetic assessment of Nerodia clarkia taeniata. Review the taxonomic and genetic assessment and evaluate if its current classification as a subspecies is supported by the best available science. Conduct fine scale surveys to generate geographic distribution and determine levels of hybridization/introgression among the different species and subspecies of water snakes that inhabit the coastal region. Continue collecting genetic samples. Extend surveyes north to include Flagler County salt marsh habitats. Draft a Species Status Assessment and update the Recovery Plan. Conduct a GIS analysis of Atlantic SMS habitat for Volusia County and northern Brevard County. Assess mangrove encroachment into salt marshes of Volusia County. Continue restoration of disturbed salt marsh areas in Volusia County and northern Brevard County. Continue exotic plant eradication programs with Atlantic SMS habitat. Acquire Atlantic SMS habitat. (USFWS, 2019)

References

U.S. Fish and Wildlife Service. 1993. Atlantic Salt Marsh Snake Recovery Plan. Atlanta, Georgia. 19 pp.

NatureServe Explorer (2015): An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://explorer.natureserve.org. (Accessed: March 22, 2016)

U.S. Fish and Wildlife Service. 2008. Atlantic salt marsh snake (Nerodia clarkii taeniata) 5-Year Review: Summary and Evaluation U.S. Fish and Wildlife Service Southeast Region Jacksonville Ecological Services Field Office Jacksonville, Florida

USFWS. 2019. Atlantic salt marsh snake (Nerodia clarkii taeniata) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Southeast Region North Florida Ecological Services Field Office Jacksonville, Florida. 19 pp.

SPECIES ACCOUNT: *Nerodia erythrogaster neglecta* (Copperbelly water snake)

Species Taxonomic and Listing Information

Listing Status: Threatened; 01/29/1997; Great Lakes-Big Rivers Region (R3) (USFWS, 2016). Recommend to up list to Endangered (USFWS, 2023).

Physical Description

A water snake in which adult total length usually is about 76 - 122 cm. Dorsum is dark, sometimes black; orange-red belly is often heavily invaded by dorsal ground color; young are with the dorsal spots often irregular and running together; keeled scales; anal scale is usually divided; total length is usually 76 - 122 cm, up to about 158 cm (Conant and Collins 1991). Minton (1972) reported that total length of seven females ranged from 73 to 142 cm, and five males were 66 - 82 cm. Newborns generally are about 22 - 26 cm in total length (Conant 1938, Minton 1972) (NatureServe, 2015).

Taxonomy

The copperbelly water snake is a subspecies of the plain-bellied water snake (Nerodia erythrogaster) (Conant 1949). There are currently five additional recognized subspecies of N. erythrogaster in North America (Gibbons and Dorcas 2004). The yellowbelly water snake (Nerodia erythrogaster flavigaster) is geographically the next closest subspecies, with a contact zone between copperbellies and yellowbellies in southern Illinois. More recently, the taxonomic revision of the water snakes resulted in a change in the North American forms of Natrix to Nerodia (Rossman and Eberle 1997) (USFWS, 2008).

Historical Range

The original range and distribution of copperbelly water snake is not precisely known. Although some early authors such as Wright and Wright (1957) depicted the northern populations as connected continuously across much of Indiana to populations further south, a notable gap exists in actual location records between the southern and northern populations (USFWS, 2008).

Current Range

Two populations occur within the area of the West Branch of St. Joseph River in Ohio and Michigan, a population occurs in the area of the Clear Fork of the East Branch of St. Joseph River in Michigan, and two populations occur within the Fish Creek watershed of Indiana and Ohio (USFWS 1997; 2010).

Distinct Population Segments Defined

Yes; Michigan, Ohio, and Indiana north of 40° N. latitude

Critical Habitat Designated

Yes;

Life History

Feeding Narrative

Adult: Diet includes primarily aquatic species such as frogs, tadpoles, salamanders, crayfish, fishes, and other aquatic invertebrates. Fishes are not a common item in the diet, probably evidently because they are uncommon or absent from the snake's typical temporary-water habitat (Minton 1972). Active from about March to October. Basks by day, forages probably mostly in evening and at night (NatureServe, 2015). Fishless wetlands that have high anuran (frog and toad) productivity are required to provide habitat and a suitable prey base. Growth is rapid, and most individuals appear to reach adult size within two full seasons of activity. They are opportunistic and will eat a variety of small fish and amphibians. Copperbellies forage both aquatically and terrestrially (USFWS, 2008).

Reproduction Narrative

Adult: Courtship and breeding principally occur in spring, although this activity may continue into summer (Conant 1934, Kingsbury 1996, Kingsbury et al. 2003). Males seek females and may aggregate around them. Mating "balls" may be observed where the female remains relatively immobile but alert while multiple males endeavor to mate with her, a mating behavior typical for natricine snakes. It is unknown whether copperbellies breed annually or less frequently, and we also lack significant information on clutch size. Gibbons and Dorcas (2004) summarized litter size for N. erythrogaster as a whole and reported that they ranged from 2 to 55, but averaged 17.7 across 53 records. Not enough data are currently available to state whether or not litter size is correlated with adult body size. (USFWS, 2008)

Geographic or Habitat Restraints or Barriers

Adult: Occurs only in wetlands and associated upland habitat (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: 35/km density, groups in spring and fall (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits lowland swamps, oxbow lakes in floodplains, brushy ditches, and other warm, quiet waters; wooded lakes, streams, or other permanent waters; and wooded corridors between these habitats (USFWS 1993). Willow-buttonbush or cypress swamps adjacent to wooded cover are needed for access to permanent wetlands and to wooded upland hibernation sites (Sellers 1991). Seeks permanent wetlands when woodland swamps seasonally begin to dry, or may stay near shallow swamp or move throughout surrounding woodland (USFWS 1993). About 500 - 600 acres of continuous swamp-forest is needed to sustain a viable population (about 50 individuals with 12 breeding pairs) (USFWS 1993). Basks on partially submerged logs and similar sites near shallow wetland edges in woodlands. Deep underground chambers in wooded uplands are the most favorable hibernation sites but the snakes also may use felled tree root networks in bottomlands, dense brushpiles, fieldstone piles, and perhaps beaver and muskrat lodges (USFWS 1993). In Indiana, density based on line transects was 4 - 26/km of shoreline; when coupled with mark-recapture results, density estimate increased to 35/km (Lacki et al. 1994). Commonly observed in groups in spring and fall (USFWS 1993). The environmental specificity is narrow; this species depends on a relatively scarce set of habitats, substrates, food types, or other abiotic and/or biotic factors within the overall range (NatureServe, 2015). The species needs habitat complexes of isolated wetlands distributed in a forested upland matrix, floodplain wetlands fed by seasonal flooding, or a combination of both. Copperbellies prefer shallow wetlands, such as shrub-scrub wetlands dominated by buttonbush (Cephalanthus occidentalis), emergent wetlands, or the margins of palustrine open water wetlands (Kingsbury 1996, Herbert 2003, Kingsbury et al. 2003, Laurent and Kingsbury 2003). Copperbellies use buttonbush swamps as basking or “loafing” areas. hibernacula are typically burrows of crayfish of the family Cambaridae, in palustrine forested wetlands and the immediately adjacent upland forest (Kingsbury 1996, Kingsbury and Coppola 2000, Hyslop 2001, Kingsbury et al. 2003) (USFWS, 2008).

Dispersal/Migration

Motility/Mobility

Adult: High (USFWS, 2008)

Migratory vs Non-migratory vs Seasonal Movements

Adult: Migratory (NatureServe, 2015)

Dispersal

Adult: Moderate (USFWS, 2008)

Dispersal/Migration Narrative

Adult: Migrates between summer and winter habitats (NatureServe, 2015). Individuals move hundreds of meters or more between wetlands and routinely use multiple wetlands over the course of an active season. Uplands are necessary for copperbellies to traverse to adjacent wetlands (USFWS, 2008).

Population Information and Trends

Population Trends:

50 - 70 % decline (NatureServe, 2015)

Species Trends:

Declining (USFWS, 2008)

Number of Populations:

4 - 5 (USFWS, 2010)

Population Size:

< 400 (inferred from USFWS, 2010)

Minimum Viable Population Size:

500 adults (USFWS, 2010)

Population Narrative:

Has been undergoing a long-term decline (50 - 70%). Now occurs in only about half of the counties from which it was once known (e.g., see Evers 1992, USFWS 1993). Regionally, the destruction of wetlands and fragmentation of intervening upland continues, promising little remittance in decline in near future. (NatureServe, 2015). None of the extant populations meet the minimum population criterion of 500 adults. During extensive survey work in the 1980s, Sellers (1987a, 1987b, 1991) reported copperbellies from 16 sites within the range of what is now the northern population segment. Surveys during the ten years prior to listing in 1997 indicated eight local populations in this range, but at the time of listing, copperbelly water snakes were found in only five local populations. Despite repeated efforts to locate copperbellies at historic or new sites (Kingsbury et al. 2003, Lee et al. 2002, Lee et al. 2005, Lee et al. 2007), only four of these populations have been confirmed since the copperbelly's listing. The best available information indicates that the copperbelly water snake northern DPS population is in the low hundreds. In the most recent surveys (2005-2006), fewer copperbelly water snakes were observed at several wetlands than had been found during previous surveys in the 1980s and 1990s and by MNFI from 2001- 2003. At its current level, the copperbelly water snake population meets both criteria set forth in the recovery plan for reclassification from threatened to endangered status (USFWS, 2010). Conclusions from surveys and mark-recapture efforts indicate that populations continue to be lost, and those that remain are in decline (USFWS, 2008). Of the seven clusters of wetlands surveyed in Ohio and Michigan during 2022, copperbellies were only found within one wetland cluster (USFWS 2023). Six (86%) of the seven copperbelly sightings were from the same wetland (USFWS 2023). It appears that many of the wetlands that were occupied by this species in previous years are no longer inhabited. Thus, the population appears to be concentrated into a smaller area. In addition, a single snake was found at La Su An Wildlife Area in 2023 indicating that very few individuals are present at this site. The capture of a gravid female in 2022 (USFWS 2023) appears to indicate that reproduction is continuing to occur in the wild (USFWS, 2023).

Threats and Stressors

Stressor: Habitat loss and fragmentation (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: Primary threat is habitat loss and fragmentation, which may lead to declines or local extirpations (USFWS 1993; Federal Register, 29 January 1997; Harding 1997). Specific examples include clearcutting woodlands, brush and land clearing, widescale draining of wetlands (especially those with seasonal water, Laurent and Kingsbury 2003), habitat constriction via surrounding development, wetland succession, and road construction (USFWS 1993). Surface mining, oil exploration and extraction, river dams that cause flooding of shallow wetlands and wooded areas, timber clearcutting, row crop expansion, and stream channelization and dredging are threats in the lower Ohio River valley and Wabash River valley (USFWS 1993). In Indiana, a population is threatened by coal mine expansion (USFWS 1993) (NatureServe, 2015).

Stressor: Pesticide use (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: Pesticide use may be detrimental if it negatively impacts aquatic food resources. Westrate (1988) suggested that the decline in frogs and salamanders in southwestern Michigan over the past 25 years may have adversely affected populations of this subspecies (NatureServe, 2015).

Stressor: Collection and human-induced mortality (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: Collecting may be a moderate problem in a few local areas (USFWS 1993). This snake if often killed by people who mistake it for a cottonmouth (Phillips et al. 1999). Road mortality is an additional threat (Harding 1997) (NatureServe, 2015). The copperbelly water snake is collected because of its rarity, large size, unique coloration, and value in the pet trade (Sellers 1991). During the first 30 years after its discovery and formal publication of its description, many copperbellies were collected as specimens for museums. Although museums have abandoned this practice, amateur collectors may continue to take wild snakes (USFWS 1997; 2008).

Stressor: Climate change (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: climate change may constitute a significant new threat for the copperbelly water snake. In the Great Lakes region, the climate will likely grow warmer and probably drier overall during the 21st century (Kling et al. 2003). Although average annual precipitation may increase slightly by the end of the century, seasonal precipitation cycles are predicted to become more extreme, with winter and spring rains increasing and summer rain decreasing by up to 50 percent. These projected declines in summer rainfall will cause drying of ephemeral wetlands, threatening the reproductive success of amphibians, such as wood frogs and salamanders (Kling et al. 2003). Copperbelly water snakes feed primarily on amphibians and are adapted to foraging in ephemeral wetlands that dry out in the summer months when copperbellies then shift to uplands (Kingsbury et al. 2003). The potential changes to ephemeral wetlands and amphibian populations, as discussed in Kling et al. (2003), may have consequences for the copperbelly, which relies on foraging for amphibians in ephemeral wetlands (USFWS, 2010).

Stressor: Predation (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Copperbellies are susceptible to a host of predators (Harding 1997). Predators include egrets and herons hunting in shallow water, and raptors hunting from the air. Raccoons, skunks, opossums, snapping turtles, and large fish represent additional predators. Predation by itself is not a threat to the population as a whole; however, when it occurs concurrently with or in addition to habitat fragmentation or other threats, predation can become a threat. During their migrations, copperbellies are vulnerable to predators (e.g., skunks, raccoons, raptors, and snapping turtles), especially when cleared areas such as roads, mowed areas, and farmlands interrupt their migration routes (USFWS, 2008).

Stressor: Disease (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: During recent surveys (2004-2006), several copperbelly water snakes were observed with blisters and other skin abnormalities indicative of blister disease (Lee, pers. comm. 2006,

Lee et al. 2007). Blister disease may occur in captive snakes and is typically associated with very humid or wet conditions. During surveys in 2004 - 2006, several wild copperbellies were observed with bumps or lesions on the body and face (Herbert, pers. comm. 2006, Lee, pers. comm. 2006). Occasional blistering is a fairly common and generally benign condition in copperbellies and other wild snakes, particularly in snakes recently emerged from hibernation (Kingsbury, pers. comm. 2007, Lee et al. 2007). Snakes often recover from blister disease after several sheds, but in more extreme and rare cases, some individuals may be unable to recover from this condition. In some cases, blister disease can result in adverse effects to the snake (e.g., facial deformities, especially around the eyes and mouth, could affect ability to forage) (Lee et al. 2007). The prevalence and degree to which this is a potential threat to the species needs further investigation (USFWS, 2008).

Stressor: Small population size/stochastic events (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The small, isolated nature of the copperbelly NPS makes them especially vulnerable to extirpation due to chance events. Any population is subject to stochastic (random) events of an environmental or demographic nature. The former is exemplified by unusually cold winters or dry summers, while an example of the latter might be that, by chance, a female had a smaller or larger than average litter size. The smaller the population, the more possible that all of these random events and their outcomes might tip the population to extirpation. In fact, Sellers (1991) felt that a severe drought in the late 1980s may have adversely impacted population sizes of copperbelly water snake, due to reduced wetland availability (i.e., fewer wetlands and shorter hydroperiods) and reduced prey base. Small populations can also suffer from inbreeding depression effects. Mating of related individuals may lead to expression of deleterious alleles, causing declines in health or reproductive output. While the research on reptiles is limited, work on other vertebrates shows increased risk of mortality from severe winters in inbred birds (Keller et al. 1994) and mice (Jimenez et al. 1994) (USFWS, 2008).

Stressor: Rusty crayfish (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Rusty crayfish (Orconectes rusticus), a species native to the Ohio River drainage, has been found at sites in southern Michigan. This invasive species is more aggressive than other crayfish and can displace native crayfish or hybridize with them (Taylor and Redmer 1996, Klocker and Strayer 2004). Rusty crayfish typically inhabit permanent pools and fast moving streams; they do not construct burrows or chimneys. At this time, the potential for rusty crayfish to displace the native crayfish population within the copperbelly's range, and the resulting impact to copperbelly hibernacula, is not known (USFWS, 2008).

Stressor: Natural resource management conflicts (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Conflicting natural resource management efforts may also threaten copperbellies. Radiotelemetry studies (Kingsbury 1995, 1996, 1998; Hyslop 2001; Herbert 2003) have

repeatedly shown that copperbellies rarely venture far into upland (terrestrial) areas that lack tree or shrub canopy. This is the case despite an affinity for small forest gaps and forest/field margins. Thus, planting and maintenance of row crops, placed next to or between wetlands, may create risks and barriers for copperbellies. Managing large areas as grassland for upland birds also likely negates use of those areas by copperbellies. Wetland management practices that stabilize and/or deepen water levels in wetlands remove key shallow and ephemeral wetland components from the landscape. Adding game fish to wetlands inhibits amphibian reproduction, thus impacting the prey base for copperbellies. Impacts from other management efforts, such as ash tree removal or chemical applications to control the emerald ash borer, are unknown (USFWS, 2008).

Stressor: Snake fungal disease (SFD) (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Snake fungal disease (SFD) is another threat to copperbelly watersnake populations. All copperbellies brought into captivity are tested for SFD. Snakes that are symptomatic will be treated. Individual adult snakes are housed separately, and other best management practices will limit the spread of SFD to individuals in captivity. Several young perished shortly after birth and samples were sent for testing but SFD was not confirmed (Cross 2022, personal communication). One individual has tested positive when it was tested due to the presence of several blisters (Cross 2023, personal communication). That individual fully recovered without treatment and later tested negative (Cross 2023, personal communication). All adults were tested as well as groups of young that are housed together and all of these tests were negative (Cross 2023, personal communication) (USFWS, 2023).

Recovery

Reclassification Criteria:
1. There are no known populations of more than 500 adults (USFWS, 2010).

2. The cumulative population size is estimated at less than 1000 adults (USFWS, 2010).

Recovery Priority Number: 3C

Delisting Criteria:
1. Multiple population viability is assured: a) Five geographically distinct populations have population sizes of more than 500 adults, with at least one population exceeding 1000 adults; or three populations must have a total population size of 3000 adults, with none less than 500, and b) These populations must persist at these levels for at least ten years (USFWS, 2010).

2. Sufficient habitat is conserved and managed: a) Wetland/upland habitat complexes sufficient to support the populations described in Criterion 1 are permanently conserved. 1) A population of 1,000 adults will require at least five square miles of landscape matrix with a high density and diversity of shallow wetlands embedded in largely forested uplands. 2) A population of 500 adults will require at least three square miles of the same type of habitat. b) Multiple (two or more) hibernacula for each population are permanently conserved. A minimum of two hibernacula will be available within one kilometer of all suitable summer habitat included above

(USFWS, 2010).

3. Significant threats due to lack of suitable management, adverse land features and uses, collection, and persecution have been reduced or eliminated: a) Habitat management and protection guidelines have been developed, distributed, and maintained. b) Adverse land features and uses, such as row crops, roads and accompanying traffic have been removed, minimized or managed within occupied Criterion 1 landscape complexes to the extent possible. c) A comprehensive education and outreach program, including persecution and collection deterrence, has been developed and implemented (USFWS, 2010).

Recovery Actions:

- Identify and conserve habitat complexes sufficient for recovery (USFWS, 2008).
- Monitor known copperbelly water snake populations and their habitat (USFWS, 2008).
- Improve baseline understanding of copperbelly water snake ecology (USFWS, 2008).
- Develop recovery approaches to enhance recruitment and population size (USFWS, 2008).
- Develop and implement public education and outreach efforts (USFWS, 2008).
- Review and track recovery progress (USFWS, 2008).
- Develop a plan to monitor copperbelly water snake after it is delisted (USFWS, 2008).
- Recommend uplisting to Endangered (USFWS, 2018).
- Identify and conserve habitat complexes sufficient for recovery ? Develop guidelines for habitat restoration and enhancement ? Restore suitable wetlands and associated uplands for the copperbelly ? Develop and implement habitat conservation programs (e.g., landowner contact, voluntary registration, and conservation agreements with landowners) ? Prioritize properties for conservation easements and acquisition; purchase, protect, and/or manage these properties based on priority and availability ? Develop landscape-level habitat characterization of copperbelly habitat (USFWS, 2010).
- Identify, assess, and reduce threats at known sites and focal management areas ? Clarify the influence of roads on migration of individual snakes and the connectivity of subpopulations ? Research and implement techniques to create road crossings for snakes to reduce road mortality and remove barriers to movement (USFWS, 2010).
- Improve baseline understanding of copperbelly water snake ecology ? Clarify characteristics of high quality hibernacula ? Clarify gestation site requirements (USFWS, 2010).
- Monitor known copperbelly water snake populations and their habitat ? Develop standard techniques for estimating population size for copperbelly water snake populations ? Monitor West Branch (OH, MI) ? Monitor Clear Fork (MI) ? Monitor Fish Creek (IN, OH) (USFWS, 2010).
- Develop and implement public education and outreach efforts ? Develop and deliver educational presentations about the copperbelly water snake ? Establish mechanisms for dissemination of information (USFWS, 2010).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Recommended future actions to proceed with the recovery of this species focus on protecting populations, habitat management and protection, research into causes of population decline, research to gain a better understanding of the species, and possible augmentation of populations. These actions are listed below with highest priority actions listed first: • Coordinate monitoring among all three states where this species’ range occurs so that information is consistent and meaningful for comparisons. • Continue to monitor this species annually in some locations to determine trends such as number of snakes observed per survey hour. • Release and monitor captive-reared individuals for reproductive output, recruitment, individual growth, and survival. • Provide adequate habitat protection for the area where copperbelly watersnakes are still present through the purchase or establishment of conservation easements based on creation of corridors for migration between suitable wetland and upland areas. • Continue to work with the Toledo Zoo to collect individuals for captive propagation and implement the captive propagation plan. • Conduct research to determine the cause of recent population declines to determine what actions could increase the viability of populations. • Continue to gather information on the prevalence of SFD and determine if it contributes to mortality of individuals. • Conduct adequate management at sites where individuals still exist. • Continue to work with private landowners to restore habitat. • Conduct additional genetic analyses using multiple data sources (e.g., comparing mitochondrial and nuclear genomic sequence data) to assess level of gene flow, genetic differentiation among subspecies, and range-wide genetic structure. • Identify, assess, and reduce threats at known sites and focal management areas. • Evaluate translocation as a method of population augmentation and potential reintroductions into historical/suitable habitats, as discussed in the captive propagation plan. • Assess the impact of predation on snakes released from the captive propagation program. • Investigate the abundance and stability of the southern population and any potential landscape level differences in habitat use and conservation. • Investigate the relevance of eDNA as a survey tool. • Develop and implement public education and outreach efforts. • Analyze morphological variation and ecological niche differentiation between subspecies. • Conduct research to determine characteristics of high-quality hibernacula and how they are dispersed in the environment. • Improve baseline understanding of copperbelly watersnake ecology (USFWS, 2023).

References

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/ecp0/. Accessed September 2016

USFWS 2010. Copperbelly Water Snake Northern Population Segment (Nerodia erythrogaster neglecta) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service East Lansing Field Office East Lansing, Michigan

U.S. Fish and Wildlife Service. 2008. Northern Population Segment of the Copperbelly Water Snake (Nerodia erythrogaster neglecta) Recovery Plan. Fort Snelling, Minnesota. ix + 79 pp. USFWS. 2023. Copperbelly Watersnake Northern Population Segment (Nerodia erythrogaster neglecta) 5-Year Review: Summary and Evaluation. USFWS, Ohio Ecological Services Field Office Columbus, Ohio 17 pages.

U.S. Fish and Wildlife Service. 2008. Northern Population Segment of the Copperbelly Water Snake (Nerodia erythrogaster neglecta) Recovery Plan. Fort Snelling, Minnesota. ix + 79 pp.

USFWS. 2010. Copperbelly Water Snake Northern Population Segment (Nerodia erythrogaster neglecta) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service East Lansing Field Office East Lansing, Michigan.

USFWS. 2023. Copperbelly Watersnake Northern Population Segment (Nerodia erythrogaster neglecta) 5-Year Review: Summary and Evaluation. USFWS, Ohio Ecological Services Field Office Columbus, Ohio 17 pages.

U.S. Fish and Wildlife Service. 2018. 5-YEAR REVIEW Copperbelly Water Snake Northern Population Segment Nerodia erythrogaster neglecta. U.S. Fish and Wildlife Service. Michigan Ecological Services Field Office. East Lansing, Michigan. 20 pp.

USFWS 2010. Copperbelly Water Snake Northern Population Segment (Nerodia erythrogaster neglecta) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service East Lansing Field Office, East Lansing, Michigan.

SPECIES ACCOUNT: *Pituophis melanoleucus lodingi* (Black pine snake)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/5/2015; Southeast Region (R4) (USFWS, 2016)

Physical Description

Pinesnakes (genus Pituophis) are large, non-venomous, oviparous (egglaying) constricting snakes with keeled scales and disproportionately small heads (Conant and Collins 1991, pp. 201–202). Their snouts are pointed. Black pinesnakes are distinguished from other pinesnakes by being dark brown to black both on the upper and lower surfaces of their bodies. There is considerable individual variation in adult coloration (Vandeventer and Young 1989, p. 34), and some adults have russet-brown snouts. They may also have white scales on their throat and ventral surface (Conant and Collins 1991, p. 203). In addition, there may also be a vague pattern of blotches on the end of the body approaching the tail. Adult black pinesnakes range from 48 to 76 inches (in) (122 to 193 centimeters (cm)) long (Conant and Collins 1991, p. 203; Mount 1975, p. 226). Young black pinesnakes often have a blotched pattern, typical of other pinesnakes, which darkens with age (USFWS, 2015).

Taxonomy

A form intermediate between the black pine snake (P. m. lodingi) and the Florida pine snake (P. m. mugitus) occurs in Baldwin and Escambia counties in Alabama and Escambia County in Florida. These snakes are separated from populations of the "true" black pine snake by the Mobile River Delta and the Alabama River (Duran 1998b). A phylogeographical study using genetic data is needed to determine whether P m. lodingi is a distinct evolutionary lineage. See also taxonomy comments for P. melanoleucus (NatureServe, 2015). Pinesnakes (Pituophis melanoleucus) are members of the Class Reptilia, Order Squamata, Suborder Serpentes, and Family Colubridae. There are three recognized subspecies of P. melanoleucus distributed across the eastern United States (Crother 2012, p. 66; Rodriguez-Robles and De JesusEscobar 2000, p. 35): The northern pinesnake (P. m. melanoleucus); black pinesnake (P. m. lodingi); and Florida pinesnake (P. m. mugitus). The black pinesnake was originally described by Blanchard (1924, pp. 531–532), and is geographically isolated from all other pinesnakes (USFWS, 2015).

Historical Range

There are historical records for the black pinesnake from one parish in Louisiana (Washington Parish), 14 counties in Mississippi (Forrest, George, Greene, Harrison, Jackson, Jones, Lamar, Lauderdale, Marion, Pearl River, Perry, Stone, Walthall, and Wayne Counties), and 3 counties in Alabama west of the Mobile River Delta (Clarke, Mobile, and Washington Counties). Historically, populations likely occurred in all of these contiguous counties; however, current records do not support the distribution of black pinesnakes across this entire area (USFWS, 2015).

Current Range

Range includes southwestern Alabama, southeastern Mississippi, and (at least formerly) extreme eastern Louisiana (Conant and Collins 1991). Current range is reduced. Surveys by Duran (1998b) indicate that black pine snakes have been extirpated from Louisiana (Washington Parish) and from two counties (Lauderdale and Walthall) in Mississippi. Black pine snakes have not been reported west of the Pearl River in either Mississippi or Louisiana in 24 years (Duran 1998b). There are no recent (post-1979) records for three additional Mississippi counties

(Greene, Jackson, and Lamar) where the snakes once occurred. Distribution of remaining populations has become highly restricted due to fragmentation of remaining longleaf pine habitat (NatureServe, 2015).

Distinct Population Segments Defined

No

Critical Habitat Designated

Yes; 3/27/2020.

Legal Description

We, the U.S. Fish and Wildlife Service (Service), designate critical habitat for the black pinesnake (Pituophis melanoleucus lodingi) under the Endangered Species Act (Act). In total, approximately 324,679 acres (131,393 hectares) in Forrest, George, Greene, Harrison, Jones, Marion, Perry, Stone, and Wayne Counties, Mississippi, and in Clarke County, Alabama, fall within the boundaries of the critical habitat designation. The effect of this regulation is to designate critical habitat for the black pinesnake under the Act (USFWS, 2020).

Critical Habitat Designation

We are designating approximately 324,679 ac (131,393 ha) in eight units (one unit divided into two subunits) as critical habitat for the black pinesnake. Those eight units are: (1) Ovett, (2) Piney Woods Creek, (3) Cypress Creek, (4A) Maxie, (4B) Maxie, (5) Howison, (6) Marion County WMA, (7) Jones Branch, and (8) Fred T. Stimpson SOA. (USFWS, 2020)

Primary Constituent Elements/Physical or Biological Features

We have determined the following PBFs for the black pinesnake: (1) PBF 1: Tract size and habitat structure. A pine forest, historically dominated by longleaf pine and maintained by frequent fire, primarily having the following characteristics: (a) An open canopy that sustains a reduced woody mid-story (<10 percent cover) and abundant, diverse, native herbaceous groundcover (at least 40 percent cover); and (b) Minimum of 5,000 ac (2,023 ha) of mostly unfragmented habitat. (2) PBF 2: Refugia sites. Naturally burned-out or rotted-out pine stumps and their associated root system tunnels, in pine forests historically dominated by longleaf pine. (3) PBF 3: Soils. Deep, sandy, welldrained soils characteristic of longleaf pine forests: (a) No flooding or ponding; (b) <15 percent medium and coarse gravel fragments; (c) >60 in (152 cm) depth to seasonal high water table; (d) >60 in (152 cm) depth to the hardpan; (e) Textural components equaling >30 percent sand and <35 percent clay; and (f) A slope <15 percent. Additional information can be found in the final listing rule and the proposed critical habitat designation for the black pinesnake. (USFWS, 2020)

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. All areas designated as critical habitat require some level of management to address the current and future threats to the black pinesnake and to maintain the PBFs. Special management of the upland longleaf pine forest would be needed to ensure an open canopy, reduced mid-story, and abundant herbaceous groundcover (PBF 1); underground refugia for snakes to occupy (PBF 2); and relatively unfragmented tracts of pine forests (PBF 1). A detailed discussion of activities affecting the black pinesnake and its habitat can be found in the final listing rule published in the Federal Register on October 6, 2015 (83 FR 51418). The features essential to the conservation of this subspecies may require special management considerations or protection to reduce threats posed by: Land use conversion, primarily urban development and conversion to agriculture and pine plantations; timber management practices such as disking, bedding, and stumping involving whole root ball removal that may cause significant subsurface disturbance; fire suppression and low fire frequencies; random effects of drought or floods; encroachment of invasive species; fragmentation from new roads or development; road mortality; and creation of utility pipelines and powerlines. Management activities that could ameliorate these threats include (but are not limited to): Maintaining critical habitat areas as open pine habitat (preferably longleaf pine); conducting forestry management using frequent prescribed burning (1 to 3 years) with seasonal variability; avoiding intensive site preparation that would disturb or destroy pine stumps or stump holes; avoiding the practice of bedding when planting trees; reducing planting densities to create or maintain an open canopied forest with abundant herbaceous groundcover; maintaining forest underground structure such as gopher tortoise burrows and small mammal burrows; and retaining large tracts of unfragmented pine forest by protecting sites from development and new road construction. More information on the special management considerations for each critical habitat unit is provided in the individual unit descriptions below (USFWS, 2020).

Life History

Feeding Narrative

Adult: Adults and immatures are carnivores. This species exhibits diurnal, crepuscular, and hibernation activity (NatureServe, 2015). Black pinesnakes are active during the day but only rarely at night. Black pinesnakes are known to consume a variety of food, including nestling rabbits (Sylvilagus aquaticus), bobwhite quail (Colinus virginianus) and their eggs, and eastern kingbirds (Tyrannus tyrannus) (Vandeventer and Young 1989, p. 34; Yager et al. 2005, p. 28); however, rodents represent the most common type of prey. The majority of documented prey items are hispid cotton rats (Sigmodon hispidus), various species of mice (Peromyscus spp.), and, to a lesser extent, eastern fox squirrels (Sciurus niger) (Rudolph et al. 2002, p. 59; Yager et al. 2005, p. 28) (USFWS, 2015).

Reproduction Narrative

Adult: Lyman et al. (2007, p. 39) described the time frame of mid-May through mid-June as the period when black pinesnakes breed at Camp Shelby, and mating activities may take place in or at the entrance to armadillo burrows. However, Lee (2007, p. 93) described copulatory behavior in a pair of black pinesnakes in late September. Based on dates when hatchling black pinesnakes have been captured, the potential nesting and egg deposition period of gravid females extends from the last week in June to the last week of August (Lyman et al. 2009, p. 42). In 2009, a natural nest with a clutch of six recently hatched black pinesnake eggs was found at Camp Shelby (Lee et al. 2011, p. 301) at the end of a juvenile gopher tortoise burrow. Longevity of wild black pinesnakes is not well documented, but can be at least 11 years, based on recapture data from Camp Shelby (Lee 2014b, pers. comm.). The longevity record for a captive male black pinesnake is 14 years, 2 months (Slavens and Slavens 1999, p. 1). Recapture and growth data from black pinesnakes on Camp Shelby indicate that they may not reach sexual maturity until their 4th or possibly 5th year (Yager et al. 2006, p. 34) (USFWS, 2015).

Geographic or Habitat Restraints or Barriers

Adult: Thick forest mid-story (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: 10 adults /square kilometer (see population narrative)

Site Fidelity

Adult: High (USFWS, 2015)

Habitat Narrative

Adult: Black pine snakes are endemic to the upland longleaf pine forests that once covered the southeastern United States. Habitat consists of sandy, well-drained soils with an overstory of longleaf pine, a fire suppressed mid-story, and dense herbaceous ground cover (Duran 1998b). Duran (1998a) found that radio-tracked black pine snakes usually were on well-drained, sandy-loam soils on hilltops, ridges, and toward the tops of slopes. They were rarely found in riparian areas, hardwood forests, or closed canopy conditions. More than half of the time, snakes were underground, usually in the trunks or root channels of rotting pine stumps. In Mississippi, each of five hibernating black pine snakes was in a shallow chamber formed by the decay and burning of pine stumps and roots (Rudolph et al. 2007). Available data indicate that black pine snakes rarely use the burrows of gopher tortoises (Duran 1998b). Fire is needed to maintain the longleaf pine ecosystem. Lowered fire frequencies and reductions in average area burned per fire event (strategies often used in management of pine plantations) produce sites with thick mid-stories. These areas are avoided by black pine snakes (Duran 1998a) (NatureServe, 2015). While they used multiple habitat types periodically, they repeatedly returned to core areas in the longleaf pine uplands and used the same pine stump and associated rotted out root system from year to year, indicating considerable site fidelity (Yager, et al. 2006, pp. 34–36; Baxley 2007, p. 40) (USFWS, 2015).

Dispersal/Migration

Motility/Mobility

Adult: Moderate (inferred from USFWS, 2015)

Migratory vs Non-migratory vs Seasonal Movements

Adult: Non-migratory (NatureServe, 2015); seasonal movements (USFWS, 2015)

Dispersal

Adult: Moderate (inferred from USFWS, 2015)

Dispersal/Migration Narrative

Adult: This species is non-migratory (NatureServe, 2015). Pinesnakes have shown some seasonal movement trends of emerging from overwintering sites in February, moving to an active area from March until September, and then moving back to their overwintering areas (Yager et al. 2006, pp. 34–36). The various areas utilized throughout the year may not have significantly different habitat characteristics, but these movement patterns illustrate that black pinesnakes may need access to larger, unfragmented tracts of habitat to accommodate fairly large home ranges while minimizing interactions with humans. Duran and Givens (2001, p. 4) estimated the average size of individual black pinesnake home ranges (Minimum Convex Polygons (MCPs)) at

Camp Shelby, Mississippi, to be 117.4 acres (ac) (47.5 hectares (ha)) using data obtained during their radio-telemetry study. A more recent study conducted at Camp Shelby, a National Guard training facility operating under a special use permit on the De Soto National Forest (NF) in Forrest, George, and Perry Counties, Mississippi, provided home range estimates from 135 to 385 ac (55 to 156 ha) (Lee 2014a, p. 1) (USFWS, 2015).

Population Information and Trends

Population Trends:

> 70% decline (NatureServe, 2015)

Number of Populations:

11 (USFWS, 2015)

Population Size:

Unknown; estimated at least 10,000 (NatureServe, 2015)

Adaptability:

Moderate (NatureServe, 2015)

Population Narrative:

This species has been extirpated from many formerly occupied areas in Louisiana, Mississippi, and Alabama (Duran 1998b, Nelson and Bailey 2004). Overall, throughout the southeastern United States, the longleaf pine ecosystem has been reduced to less than 5 percent of its historical extent. This species has experienced a long-term decline of > 70%. Total adult population size is unknown. Conservatively assuming an average of 0.1 adults per hectare (10/square kilometer) of suitable habitat and at least 1,000 square kilometers of occupied suitable habitat, estimated population size would be at least 10,000. This species is considered moderately vulnerable to current threats (NatureServe, 2015). The Service estimates that 11 of the 14 populations of black pinesnakes remain extant today (USFWS, 2015).

Threats and Stressors

Stressor: Fragmentation and degradation of longleaf pine habitat (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: Historical distribution is highly correlated with the historical range of the longleaf pine ecosystem (Duran 1998b). Longleaf pine forest in the southeast has been reduced to less than 5 percent of its original extent (Frost 1993, Outcalt and Sheffield 1996). In the range of the black pine snake, longleaf pine is now largely confined to isolated patches on private land and the DeSoto National Forest (DNF) in Mississippi. Habitat has been eliminated through land use conversions, primarily urban development and conversion to agriculture and pine plantations. Most of the remaining patches of longleaf pine on private land are fragmented, degraded, second-growth forests. Conversion of longleaf pine forest to pine plantation often reduces the quality and suitability of a site for black pine snakes. Forest management practices such as fire suppression, increased stocking densities, and removal of downed trees and stumps, combined with younger harvest ages of trees, all contribute to degradation of preferred habitat attributes

(Rudolph et al. 2007). Fragmentation and degradation of longleaf pine habitat are continuing. The coastal counties of southern Mississippi and Mobile County, Alabama, are being developed at a rapid rate due to increases in the human population. Urbanization appears to have greatly reduced historical black pine snake populations in Mobile County, Alabama (Duran 1998b) (NatureServe, 2015).

Stressor: Road mortality (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: Roads surrounding and traversing the remaining habitat pose a threat. Lalo (1987) estimated that one million individual vertebrates are killed per day on roads in the United States. Black pine snakes frequent the sandy hilltops and ridges where roads are most frequently sited. During Duran's (1998a) study. Seventeen percent of the black pine snakes with transimtters were killed while attempting to cross a road (NatureServe, 2015).

Stressor: Hunting (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: In many parts of Louisiana, Mississippi, and Alabama, there is a lack of understanding of the importance of snakes to a healthy ecosystem. Snakes are often killed intentionally when they are observed. Duran (1998a) found a dead black pine snake that had been shot. In another instance, the tracks of a 4-wheel drive vehicle could be seen swerving to the wrong side of the road and into a ditch where a flattened dead black pine snake was found. As development pressures increase on the remaining black pine snake habitat, especially in Mobile County, Alabama, human/snake interactions will increase and frequently result in the death of the snake (NatureServe, 2015).

Stressor: Low reproductive rates (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: Duran (1998a) suggested that reproductive rates of wild black pine snakes may be low. Thus, the loss of mature adults, through road mortality or direct killing, increases in significance. As existing occupied habitat becomes reduced in quantity and quality, low reproductive rates threaten population viability (NatureServe, 2015).

Stressor: Pet trade (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: Direct take of black pine snakes for recreational, scientific, or educational purposes is not currently considered to be a threat. However, there is some indication that collecting for the pet trade may be a problem (Duran 1998b) (NatureServe, 2015).

Stressor: Predation (USFWS, 2015)
Exposure:

Response:
Consequence:
Narrative: Red imported fire ants (Solenopsis invicta), an invasive species, have been implicated in trap mortalities of black pinesnakes during field studies (Baxley 2007, p. 17). They are also potential predators of black pinesnake eggs, especially in disturbed areas (Todd et al. 2008, p. 544), and have been documented predating snake eggs under experimental conditions (Diffie et al. 2010, p. 294). In 2010 and 2011, trapping for black pinesnakes was conducted in several areas that were expected to support the subspecies; no black pinesnakes were found, but high densities of fire ants were reported (Smith 2011, pp. 44–45). However, the severity and magnitude of effects, as well as the long-term effects, of fire ants on black pinesnake populations are currently unknown. Other potential predators of pinesnakes include red-tailed hawks, raccoons, skunks, red foxes, and feral cats (Ernst and Ernst 2003, p. 284; Yager et al. 2006, p. 34). Lyman et al. (2007, p. 39) reported an attack on a black pinesnake by a stray domestic dog, which resulted in the snake's death. Several of these mammalian predators are anthropogenically enhanced (urban predators); that is, their numbers often increase with human development adjacent to natural areas (Fischer et al. 2012, pp. 810–811). However, the severity and magnitude of predation by these species are unknown (USFWS, 2015).

Stressor: Inadequacy of regulatory mechanisms (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Outside of the National Forest and the area covered by the INRMP, existing regulatory mechanisms provide little protection from the primary threat of habitat loss for the black pinesnake. Longleaf restoration activities on Forest Service lands in Mississippi conducted for other federally listed species do improve habitat for black pinesnake populations located in those areas, but could be improved by ensuring the protection of the belowground refugia critical to the snake (USFWS, 2015).

Stressor: Exotic plants (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Exotic plant species degrade habitat for wildlife. In the Southeast, longleaf pine forest associations are susceptible to invasion by the exotic cogongrass (Imperata cylindrica), which may rapidly encroach into areas undergoing habitat restoration, and is very difficult to eradicate once it has become established, requiring aggressive control with herbicides (Yager et al. 2010, pp. 229–230). Cogongrass displaces native grasses, greatly reducing foraging areas, and forms thick mats so dense that ground-dwelling wildlife has difficulty traversing them (DeBerry and Pashley 2008, p. 74) (USFWS, 2015).

Stressor: Erosion control blankets (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: On many construction project sites, erosion control blankets are used to lessen impacts from weathering, secure newly modified surfaces, and maintain water quality and ecosystem health. However, this polypropylene mesh netting (also often utilized for bird

exclusion) has been documented as being an entanglement hazard for many snake species, causing lacerations and sometimes mortality (Stuart et al. 2001, pp. 162–163; Barton and Kinkead 2005, p. 34A; Kapfer and Paloski 2011, p. 1). This netting often takes years to decompose, creating a long-term hazard to snakes, even when the material has been discarded (Stuart et al. 2001, p. 163). Although no known instance of injury or death from this netting has been documented for black pinesnakes, it has been demonstrated to have negative impacts on other terrestrial snake species of all sizes and thus poses a potential threat to the black pinesnake when used in its habitat (USFWS, 2015).

Stressor: Stochastic events (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Random environmental events may also play a part in the decline of the black pinesnake. Two black pinesnakes were found dead on the De Soto NF during drought conditions of midsummer and may have succumbed due to drought-related stress (Baxley 2007, p.41) (USFWS, 2015).

Recovery

Reclassification Criteria:
Not available - this species does not have a recovery plan.

Recovery Priority Number: 12

Delisting Criteria:
Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.
- The largest known populations of black pinesnakes (5 of 11) occur in the De Soto NF, which is considered the core of the subspecies' known range. The black pinesnake likely receives benefit from longleaf pine restoration efforts, including prescribed fire, implemented by the U.S. Forest Service in accordance with its Forest Plan, in habitats for the federally listed gopher tortoise, dusky gopher frog, and redcockaded woodpecker. (USDA 2014, pp. 60–65). Within the recently revised Forest Plan, black pinesnakes are included on lists of species dependent on fire to maintain habitat, species sensitive to recreational traffic, species that are stump and stump-hole associates, and species sensitive to soil disturbance (USDA 2014, Appendix G– 85, G–92, G–100). The management strategies described within the Forest Plan provide general guidance that states project areas should be reviewed to determine if such species do occur and if so to develop mitigation measures to ensure sustainability of the species, such as, in general, not removing dead and downed logs or other woody debris from rare communities (USFWS, 2015).
- The MSARNG updated its INRMP in 2014, and outlined conservation measures to be implemented specifically for the black pinesnake on lands owned by the DoD and the State of Mississippi on Camp Shelby. Planned conservation measures include: Supporting research and surveys on the subspecies; habitat management specifically targeting the black pinesnake, such as retention of pine stumps and prescribed burning; and educational

programs for users of the training center to minimize negative impacts of vehicular mortality on wildlife (MSARNG 2014, pp. 93–94). However, the INRMP addresses integrative management and conservation measures only on the lands owned and managed by DoD and the State of Mississippi (15,195 ac (6,149 ha)), which make up approximately 10 percent of the total acreage of Camp Shelby (132,195 ac (53,497 ha)). Most of this land is leased to DoD and owned by the Forest Service, which manages the land in accordance with its Forest Plan (see explanation above). Only 5,735 ac (2,321 ha) of the acreage covered by the INRMP provides habitat for the black pinesnake (USFWS, 2015).

- Longleaf pine habitat restoration projects have been conducted on selected private lands within the range historically occupied by the black pinesnake and likely provide benefits to the subspecies (U.S. Fish and Wildlife Service 2012, pp. 12–13). Additionally, restoration projects have been conducted on wildlife management areas (WMAs) (Marion County WMA in Mississippi; Scotch, Fred T. Stimpson, and the area formerly classified as the Boykin WMAs in Alabama) occupied by or within the range of the black pinesnake, and on three gopher tortoise relocation areas in Mobile County, Alabama. The gopher tortoise relocation areas are managed for the open canopied, upland longleaf pine habitat used by both gopher tortoises and black pinesnakes, and there have been recent records of black pinesnakes on the properties; however, the managed areas are all less than 700 ac (283 ha) and primarily surrounded by urban areas with incompatible habitat (USFWS, 2015).

References

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/speciesProfile/. Accessed April 2016

USFWS 2015. Endangered and Threatened Wildlife and Plants

Threatened Species Status for Black Pinesnake With 4(d) Rule. 80 Federal Register 193. October 6, 2015. Pages 60467 - 60489.

USFWS. 2020. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for Black Pinesnake. Final rule. FR Vol. 85, No. 38. Pages 11238-11270.

USFWS. 2015. Endangered and Threatened Wildlife and Plants

SPECIES ACCOUNT: *Pituophis ruthveni* (Louisiana pine snake)

Species Taxonomic and Listing Information

Listing Status: Proposed threatened; 11/6/2016. Threatened: May 7, 2018.

Physical Description

Pine snakes (genus Pituophis) are large, short-tailed, non-venomous, powerful constricting snakes with keeled scales, a single anal plate (the scale covering the cloaca) and disproportionately small heads (Conant and Collins 1991, pp. 201-202). Their snouts are pointed and they are good burrowers. The Louisiana pine snake (P. ruthveni) has a buff to yellowish background color with dark brown to russet dorsal blotches covering its total length (Vandeventer and Young 1989, p. 35; Conant and Collins 1991, p. 203). The belly of the Louisiana pine snake is unmarked or boldly patterned with black markings. The Louisiana pine snake is variable in both coloration and pattern, but a characteristic feature is that its body markings are always conspicuously different at opposite ends of its body. Blotches run together near the head, often obscuring the background color, and then become more separate and well-defined towards the tail. Typically, there are no noticeable head markings, although rarely a light bar or stripe may occur behind the eye. The length of adult Louisiana pine snakes ranges from 122 to 142 centimeters (cm) (48 to 56 inches (in)) (Conant and Collins 1991, p. 203). The largest reported specimen was 178 cm (5.8 feet (ft)) long (Davis 1971, p. 145; Conant and Collins 1991, p. 203).

Taxonomy

The Louisiana pine snake is a member of the Class Reptilia, Order Squamata, Suborder Serpentes, and Family Colubridae. Stull (1929, pp. 2-3) formally described the Louisiana pine snake as a pine snake subspecies (P. melanoleucus ruthveni) based on two specimens taken in Rapides Parish, Louisiana. Reichling (1995, p. 192) reassessed this snakes taxonomic status and concluded that the Louisiana pine snake was geographically isolated and phenotypically distinct, and thus a valid evolutionary species. The Louisiana pine snake has subsequently been accepted as a full species, P. ruthveni (Crother 2000, p. 69; Rodriguez-Robles and Jesus-Escobar 2000, p. 46; Collins and Taggert 2002, p. 33).

Historical Range

See current range/distribution

Current Range

Louisiana: Bienville, Beauregard, Jackson, Natchitoches, Rapides, Sabine, and Vernon counties; Texas: Angelina, Cherokee, Haradin, Houston, Jasper, Nacogdoches, Newton, Polk, Sabine, San Augustine,Shelby, Trinity, and Wood counties. The Louisiana pine snake historically occurred in portions of northwest and west-central Louisiana and extreme east-central Texas (Conant 1956, p. 19). It is extremely likely that undocumented populations of this species historically occurred but were lost before the 1930s, since virtually all virgin timber in the south was cut during intensive logging from 1870 to 1920 (Frost 1993, p. 38).

Critical Habitat Designated

Yes;

Life History

Feeding Narrative

Adult: Louisiana pine snakes appeared to be most active March-May and September-November (especially November) and least active December-February and summer (especially August) (Himes 1998, p. 12). Louisiana pine snakes were observed by Ealy et al. (2004, p. 391) to be semi-fossorial and essentially diurnal. Ealy et al. (2004, p. 390) documented that the species spent 59 percent of daylight hours (sunrise to sunset) below ground and moved an average of 163 meters (m) (541 ft) per day. Furthermore, Louisiana pine snakes in east Texas were relatively immobile (i.e., moved less than 10 m (33 ft)) on 54.5 percent of days monitored and all recorded movements occurred during daytime (Ealy et al. 2004, p. 391). Adult males in Louisiana moved an average of 150 m (495 ft) daily, adult females 106 m (348 ft), and juveniles 34 m (112 ft) (Himes 1998, p. 18). Additionally, Bair'ds pocket gophers are the primary prey of the Louisiana pine snake (Himes 2000, p. 97; Rudolph et al. 2002, p. 58) comprising an estimated 53 percent of available individual prey records (Rudolph et al. 2012, p. 243), although the species has also been known to eat eastern moles (Scalopus aquaticus), cotton rats (Sigmodon hispidus), deer mice (Peromyscus sp.), harvest mice (Reithrodontomys sp.), and turtle (probably Trachemys scripta) eggs (Rudolph et al. 2002, p. 59, Rudolph et al. 2012, p. 244).

Reproduction Narrative

Adult: Louisiana pine snake sexual maturity is attained at an approximate length of 120 cm (4 ft) and an age of approximately three years (Himes et al. 2002, p. 686). The Louisiana pine snake is oviparous, with a gestation period of about 21 days (Reichling 1988, p. 77), followed by 60 days of incubation. Having the smallest clutch size (3 to 5) of any North American colubrid snake, the Louisiana pine snake is limited by a remarkably low reproductive rate (Reichling 1990, p. 221). However, the Louisiana pine snake produces the largest eggs (generally 12 cm (5 in) long and 5 cm (2 in) wide) of any U.S. snake (Reichling 1990, p. 221). It also produces the largest hatchlings reported for any North American snake, ranging 45 to 55 cm (18 to 22 in) in length, and up to 107 grams (g) in weight (Reichling 1990, p. 221). Captive Louisiana pine snakes can live over 30 years, but females have not reproduced beyond the age of 18 years (Reichling 2008a, p. 4, Appendix A).

Geographic or Habitat Restraints or Barriers

Adult: Busy highway or highway with obstructions such that snakes rarely if ever cross successfully; major river, lake, pond, or deep marsh (this barrier pertains only to upland species and does not apply to aquatic or wetland snakes); densely urbanized area dominated by buildings and pavement (NatureServe).

Environmental Specificity

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

Site Fidelity

Adult: High fidelity to hibernacula

Dependency on Other Individuals or Species for Habitat

Adult: Bairds pocket gopher burrows

Habitat Narrative

Adult: Louisiana pine snakes are endemic to the westerly extent of the longleaf pine (Pinus palustris) ecosystem that historically existed in Louisiana and Texas. Louisiana pine snake habitat consists of sandy, well-drained soils in open pine forest (especially longleaf-pine savanna), a sparse midstory, and well-developed herbaceous ground cover dominated by grasses and forbs (Rudolph and Burgdorf 1997, p. 117). Abundant ground-layer herbaceous vegetation is important for the Louisiana pine snake and their primary prey, the Bairds pocket gopher (Geomys breviceps). These fire-climax park-like conditions are created and maintained by recurrent low-intensity ground fires that occur on a 3 to 5 year return interval. In the absence of recurrent fire, suitable Louisiana pine snake habitat conditions are lost due to vegetative succession. Louisiana pine snakes have also been found in grasslands and pine plantations that contain sufficient herbaceous ground cover and sandy soils (Reichling et al. 2008, p. 9).

Dispersal/Migration

Motility/Mobility

Adult: Low

Migratory vs Non-migratory vs Seasonal Movements

Adult: Non-migratory

Dispersal

Adult: Low

Dispersal/Migration Narrative

Adult: It has been documented that the species spends 59 percent of daylight hours (sunrise to sunset) below ground and moves an average of 163 meters (m) (541 ft) per day) (Ealy et al. 2004, p. 390). Furthermore, Louisiana pine snakes in east Texas were observed to be relatively immobile (i.e., moved less than 10 m (33 ft)) on 54.5 percent of days monitored and all recorded movements occurred during daytime (Ealy et al. 2004, p. 391). Adult males in Louisiana moved an average of 150 m (495 ft) daily, adult females 106 m (348 ft), and juveniles 34 m (112 ft) (Himes 1998, p. 18).

Population Information and Trends

Population Trends:

Declining

Species Trends:

Declining

Number of Populations:

6 (USFWS, 2023)

Population Size:

Adult population size is unknown, but relatively small and presumably at least a few thousand (NatureServe).

Population Narrative:

The Louisiana pine snake is recognized as one of the rarest snakes in North America (Young and Vandeventer 1988, p. 203; Himes et al. 2006, p. 114). The Louisiana pine snake was classified in 2007 as endangered on the IUCN (World Conservation Union) Red List of Threatened Species (version 3.1; http://www.iucnredlist.org/). Because basic life history information is lacking for this species and current sampling methodology cannot determine population density, no estimates exist regarding the acreage or population size necessary to support a viable Louisiana pine snake population. Without management, the current and future status of the Louisiana pine snake will be influenced by the likelihood that all remnant Louisiana pine snake populations will remain demographically and genetically isolated into the future. Due to its semi-fossorial habits, rarity, and secretive nature, Louisiana pine snakes are difficult to locate and trap, even in areas where they are known to occur (Ealy et al. 2004, p. 384). To date, most Louisiana pine snake records have been from trapping and opportunistic sightings. Trapping effort data are used to estimate trap success (i.e., the number of trap days required to catch one snake) for each population. Trapping has provided important information on Louisiana pine snake occurrences. However, population densities cannot be reliably estimated from trapping data because mark-recapture analyses cannot be conducted without sufficient numbers of Louisiana pine snake recaptures. Consequently, no estimates of Louisiana pine snake population densities exist. However, the current, best available indices of estimated Louisiana pine snake abundance are trap successand other types of occurrence records.   The Louisiana pinesnake is a large, short-tailed, non-venomous, constricting snake currently found in open canopy pine-dominated ecosystems in west-central Louisiana and East Texas. While the species is considered extirpated from a significant portion of its historical range, it continues to occupy six natural populations in four parishes in Louisiana and three counties in Texas, as well as a seventh population founded from individuals produced from a captive propagation program. The seven populations are represented by seven distinct Estimated Occupied Habitat Areas, which are small and isolated from each other and have low or very low resilience (USFWS, 2023).

Threats and Stressors

Stressor: Habitat fragmentation from historical loss and degradation
Exposure:
Response:
Consequence:
Narrative: The historical loss, degradation, and fragmentation of the longleaf pine ecosystem across the entire Louisiana pine snake historical range have resulted in six naturally extant Louisiana pine snake populations that are isolated and small. Habitat fragmentation on private lands in the matrix between extant populations has essentially eliminated the potential for successful dispersal among remnant populations, as well as the potential for natural re-colonization of vacant or extirpated habitat patches. Currently, the amount of habitat required to support viable Louisiana pine snake populations, and the necessary distribution of this habitat over the landscape, is not known.

Stressor: Fire suppression
Exposure:
Response:
Consequence:
Narrative: The disruption of natural fire regimes, due to fire suppression and inadequate, infrequent prescribed burning, is the leading factor responsible for the degradation of the small

amount of remaining longleaf pine forest (Rudolph and Burgdorf 1997, p. 118), and may represent one of the greatest threats to existing Louisiana pine snake habitat quality in recent years (Rudolph 2000, p. 7). In the absence of frequent and effective fires, upland pine savannah ecosystems rapidly develop a mid-story of hardwoods and off-site species which suppress or eliminate any herbaceous understory. Since the presence of pocket gophers is directly related to the extent of herbaceous vegetation available to them, their population numbers and distribution decline as such vegetation declines. The resulting reduction of pocket gophers and their distribution directly impacts the number and distribution of Louisiana pine snakes. The use of prescribed burning is heavily reduced on private timberlands because of the expense of liability insurance, legal liability, the planting of off-site pinespecies which have a reduced tolerance to fire, limited funds and personnel, and smoke management issues.

Stressor: Herbicides
Exposure:
Response:
Consequence:
Narrative: Industrial pine plantations containing off-site pine species are often managed with herbicides instead of prescribed burning. Most of these forests have sparse and poorly structured understory plant communities, an early successional trait that is present throughout the rotation, rendering them generally unsuitable for pocket gophers. Herbicide-use may alter the composition and/or density of the ground cover vegetation in a way that causes pocket gopher decline thus affecting Louisiana pine snake numbers as well (Rudolph and Burgdorf 1997, p. 118).

Stressor: Demographic and genetic factors
Exposure:
Response:
Consequence:
Narrative: The Louisiana pine snake has an extremely low reproductive rate, producing a very small clutch of four eggs on average (Reichling 1990, p. 221). The Louisiana pine snakes low fecundity and low population growth rate magnifies the effect of all other threats and increases the likelihood of local extirpations. The minimum population size required to maintain self-sustaining populations of the Louisiana pine snake is unknown. However, small, isolated populations are vulnerable to the threats of decreased demographic viability, increased susceptibility of extirpation from stochastic environmental factors (e.g., weather events, disease), and the potential loss of valuable genetic resources resulting from genetic isolation and subsequent inbreeding depression and genetic drift. Additionally, it is extremely unlikely that habitat corridors linking extant populations will be secured and restored; therefore, the loss of any extant population will be permanent without future reintroduction of captive-bred individuals.

Stressor: Road mortality
Exposure:
Response:
Consequence:
Narrative: Roads and associated vehicular traffic have been identified as important causes of snake mortality and population declines (Rudolph et al. 1999, p. 130; Himes et al. 2002, p. 686). Himes et al. (2002, p. 686) documented the death of 15 Louisiana pine snakes during their radio-telemetry study in Louisiana and Texas. Three of the 15 (20 percent) deaths could be attributed

to vehicle mortality. Roads with moderate to high traffic levels reduce adjacent snake populations by 50 to 75 percent and measurable impacts extend up to 850 m (approximately 0.5 mi) from the roads (Rudolph et al. 1999, p. 130). The threat of road mortality may be highest in the Longleaf Ridge Area of the south Angelina National Forest (Compartments 74 through 77, 79 through 92, and south portions of 73 and 78). Off-road vehicle use may also cause significant impacts to the Louisiana pine snake. However, no significant data exists to quantify the impact of off-road vehicle use.

Stressor: Entanglement in erosion control blankets
Exposure:
Response:
Consequence:
Narrative: A recently identified threat for many snake species is entanglement in filamentous mesh (particularly synthetic, non-biodegradable types) used in erosion control blankets (ECBs) installed on pipeline and road construction rights-of-ways and has been documented by Kapfer and Paloski (2011, p. 1). ECBs can result in direct Louisiana pine snake mortality due to entanglement. Rudolph (2011b in litt.) demonstrated that synthetic ECB material caused immediate entanglement and snakes were unable to extract themselves after exposure. Extensive pipeline construction associated with Haynesville shale gas and oil exploration activities, and the subsequent increase in the use of ECBs, is a particular threat to the Bienville, LA population (Rudolph 2011a in litt.).

Stressor: Intentional killing
Exposure:
Response:
Consequence:
Narrative: Malicious killing of snakes by humans is a significant issue in snake conservation because snakes arouse fear and resentment from the general public (Bonnet et al. 1999, p. 40). Intentional killing of black pine snakes (Pituophis melanoleucus) by humans along the Gulf Coast has been documented (USFWS 2007, p. 8). The intentional killing of Louisiana pine snakes by humans is likely, but the extent of the impact of this stressor isunknown. The USFWS does not have information related to the implementation, compliance, or enforcement of the existing regulatory mechanisms by the states or Federal land managers.

Stressor: Collection for pet trade
Exposure:
Response:
Consequence:
Narrative: In Texas, the Louisiana pine snake is listed as state threatened and prohibited from unauthorized collection. As of February 2013, unpermitted killing or removal from the wild is prohibited in Louisiana. Collection or harassment of Louisiana pine snakes is prohibited on USFS properties in Louisiana (USFS 2002, p. 1). The capture, removal, or killing of non-game wildlife from Fort Polk and Peason Ridge (DOD lands) is prohibited without a special permit (U.S. Department of the Army 2008, p. 6; U.S. Department of the Army 2013, p. 51). However, those regulations do not protect the habitat of the species which has declined.

Recovery

Reclassification Criteria:
Recovery Priority Number: 8C

Recovery Actions:
- Ensure that habitat will be managed long-term for the benefit of this snake by continuing to present the option of CCAAs to willing landowners in significant portions of the Louisiana pine snake's range.
- Develop a Conservation Strategy to outline the highest priority conservation efforts for the Louisiana pine snake.
- Improve status assessment by continuing or re-establishing Louisiana pine snake trapping within the known OHMCPs and additional areas that the LRSF Model has shown to be preferable to snakes outside of the OHMCPs.
- Improve assessment of Louisiana pine snake population status and range by continuing to pursue access to survey additional private lands across the historical range of the species, facilitated by the LRSF Model.
- Increase the potential observation of this difficult-to-trap species by continuing to pursue potentially better methods of occurrence monitoring, such as pressure-activated or time-lapse camera traps.
- Begin field evaluation of and actual surveys with the two scent-detection dogs that are currently being trained under the guidance of the Memphis Zoo and Louisiana Department of Wildlife and Fisheries.
- Enhance existing and/or establish longleaf pine forests within occupied and preferable Louisiana pine snake habitat.
- Within occupied and preferable Louisiana pine snake habitat, reduce and/or remove the midstory component within pine forest stands to a level that allows maintenance by prescribed burning.
- Implement a prescribed-burning program (typical 3 to 5-year intervals once the forest is in a maintenance condition) to reduce the midstory forest component and maintain the herbaceous layer within occupied and preferable Louisiana pine snake habitat.
- Reduce timber stand density through selective thinning to allow sunlight to reach the ground thereby enhancing the herbaceous layer and pocket gopher habitat within occupied and preferable Louisiana pine snake habitat.
- Manage timber primarily for ecological restoration or on longer rotations and for higher end products such as saw timber and poles within occupied and preferable Louisiana pine snake habitat.
- Limit off-road vehicular use and consider/continue road closures within occupied and preferable Louisiana pine snake habitat.
- Provide conservation education to the general public, and to managers, hunters and other recreational users to avoid killing or otherwise impacting snakes in the wild.
- Educate collectors and other members of the public on the rarity of the Louisiana pine snake and the need to refrain from removing the species from the wild.
- Continue captive breeding and experimental reintroduction program to enhance populations within suitable habitat actively managed for Louisiana pine snake.
- Continue to progress on the assessment of captive-breeding stock and wild-caught specimen genetics to attempt to determine long-term viability of the species.
- Guide decision-making for management of captive stocks and the reintroduction program through the use of genetics assessment and analysis results.

- Acquire funding and encourage research on pocket gophers through an addition to the Louisiana Wildlife Action Plan.
- Recovery Priority Number: 8C (USFWS, 2018)
- Recovery actions (not in priority order) include: 1. Identify better methods to locate unknown inhabited areas and initiate searches for new populations to include other areas (for example those referenced in the listing rule). We have begun communications to the public for citizen science efforts. 2. Reevaluate unconventional search methods like scent dogs and find solutions to previously identified obstacles to securing those services. 3. Evaluate terrestrial eDNA methods for detection of the species. 4. Identify large unfragmented tracts ofland in Louisiana and Texas for additional reintroduction efforts. Must have relatively few roads and preferable or suitable soils. 5. Consider the development ofHCPs, SHAs, and other means of voluntary habitat improvement with private landowners, especially in Texas where a CCAA was not available prior to listing. 6. Use section 4(d) of the Endangered Species Act to allow specific exemptions that will facilitate cooperation and beneficial habitat stewardship with private citizens. 7. Conduct research to further the knowledge of life history requirements of the Louisiana pinesnake and apply the results toward management and protection of the species. Refine life history investigations to include aspects of environmental temperature tolerances, nesting requirements in the wild, required habitat patch size and degree of connectivity, and viability of populations. 8. Continue to refine and implement technology for maintaining and propagating the Louisiana pinesnake in captivity. Investigate the potential use of captive-reared or translocated Louisiana pinesnakes to augment existing natural populations or repopulate a previously occupied habitat where suitable conditions exist or can be restored. 9. Cooperate and assist with planned efforts to use wild caught male snakes as donors for artificial insemination of captive females in order to increase the genetic variability of the captive population which was grown from relatively few founders. 10. Continue to closely monitor incidence of SFD in populations and develop and implement procedures during trapping and other handling to reduce spreading of the fungus to uninfected individuals. 11. Determine causes for lack of evidence of population increases in areas where suitable habitat has been restored and is currently maintained. 12. Reevaluate and modify trapping methods or increase trapping efforts. 13. Develop a more accurate and efficient method to determine pocket gopher abundance 14. Determine the recruitment rate to, and amount of pocket gophers in newly created suitable habitat and explore the feasibility of artificial enrichment of pocket gophers in those areas. 15. Research the specific requirements (i.e., high value forage species, minerals, etc.) needed for optimum growth and reproduction of the pocket gopher and potentially further enhance newly created habitat. 16. Investigate methods to reduce vehicle mortality (e.g., fencing, culvert crossings, reduced speed zones) in occupied areas in near proximity to roads. 17. Encourage and work with all landowners to restore, enhance, and manage habitat to expand suitable habitat for the Louisiana pinesnake, particularly within and adjacent to estimated occupied habitat areas. 18. Continue to closely monitor existing Louisiana pinesnake populations (USFWS, 2018).
- Within occupied and preferable Louisiana pine snake habitat, reduce and or remove midstory component within pine forest stands to a level that allows maintenance by prescribed burning.

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES This species does not have a final recovery plan. While completing this status review, we have identified the following potential recovery activities which are included below that should be prioritized for the recovery of the species. Recovery Activities • Protect and manage Louisiana pinesnake habitat in the following priority if possible: (1) currently occupied or designated critical habitat, (2) strategically located near existing populations and currently suitable but unoccupied, (3) strategically located near existing populations and currently unsuitable, but potentially suitable if beneficial management applied. • Support and expand the captive breeding program, including increasing novel genes and overall diversity in the captive population, reintroduction to create new populations, and population augmentation for the Louisiana pinesnake across its range according to the USFWS Controlled Propagation and Reintroduction Plan. • Provide support and funding for longleaf pine restoration and prescribe burning in upland pine and associated habitats within and adjacent to the delineated EOHA on private and Federal lands. Monitoring and Research Activities • Conduct or fund research to aid recovery efforts for the Louisiana pinesnake and apply adaptive management where appropriate. • Continue, refine, and expand a monitoring (presence, abundance, condition, health, etc.) protocol for the Louisiana pinesnake and its habitat to allow future assessment of population viability. • Expand public outreach and education efforts for youth, hunters, and outdoors enthusiasts about all aspects of the recovery actions. • Identify potential interpopulation habitat corridor locations and secure agreements to protect and restore suitable habitat in those areas (USFWS, 2023).

References

USFWS 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for Pituophis ruthveni (Louisiana Pine Snake). U.S. Fish and Wildlife Service, Region 4 (Southeast Region)

April 23, 2014

34 p.

34 p. USFWS. 2023. Louisiana Pinesnake (Pituophis ruthveni) 5-Year Status Review: Summary and Evaluation. Southeast Region. Louisiana Ecological Services Office. Lafayette, Louisiana. 11 pages.

USFWS. 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for Pituophis ruthveni (Louisiana Pine Snake). U.S. Fish and Wildlife Service, Region 4 (Southeast Region)

U.S. Fish and Wildlife Service. 2018. Recovery Outline For Louisiana pinesnake (Pituophis ruthveni). 6 pp.

USFWS. 2023. Louisiana Pinesnake (Pituophis ruthveni) 5-Year Status Review: Summary and Evaluation. Southeast Region. Louisiana Ecological Services Office. Lafayette, Louisiana. 11 pages.

SPECIES ACCOUNT: *Pseudemys alabamensis* (Alabama red-belly turtle)

Species Taxonomic and Listing Information

Listing Status: Endangered; June 16, 1987; Southeast region (R4)

Physical Description

This is a relatively large, freshwater, herbivorous turtle attaining a carapace length of 33 centimeters (13 inches). It normally has an orange to red plastron and at the tip of the upper jaw a prominent notch bordered on each side by a toothlike cusp. The elongate carapace is high-domed, its highest point often anterior to midbody, where the carapace is widest. The background carapace coloration is brown, olive, or black with yellow, orange, or red distinct vertical markings. The skin is olive to black with yellow to light orange striping (USFWS, 1989).

Taxonomy

Characteristics most useful for distinguishing this species from other members of its genus include the number and configuration of stripes on the head (Ernst and Barbour 1972, Mount 1975, Dobie 1985a, 1986) and the presence of flanking cusps on each side of a terminal notch in the upper jaw. The Alabama red-bellied turtle has more stripes than the Florida red-bellied turtle (Pseudemys nelsoni), and both the former and latter have a prefrontal arrow normally absent in the river cooter (Pseudemys concinna) and the Florida cooter (Pseudemys floridana) (USFWS, 1989).

Historical Range

Formerly throughout the lower part of the Mobile River system below David Lake, Baldwin and Mobile counties, Alabama; as far north as the Little River State Park in southern Monroe County, and perhaps east into the Florida Panhandle as far as Apalachee Bay (NatureServe, 2015).

Current Range

Mobile Bay and tributary streams, Baldwin and Mobile counties, Alabama; apparently most abundant from Hurricane Landing on Tensaw River south to northern part of Mobile Bay north of Interstate Highway 10 (Dobie and Bagley 1988) (NatureServe, 2015).

Distinct Population Segments Defined

No

Critical Habitat Designated

No;

Life History

Feeding Narrative

Adult: Eats primarily aquatic plants (Mount 1975) (NatureServe, 2015).

Reproduction Narrative

Adult: Lays clutch or clutches of 3-9 eggs, May to July (Behler and King 1979, Dobie and Bagley 1988) (NatureServe, 2015).

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from NatureServe, 2015)

Site Fidelity

Adult: Low (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Most abundant in quiet backwaters of upper Mobile Bay in areas with dense submerged vegetation, in water generally 1-2 m deep; also in river channels; occurs only as a straggler in brackish water and salt marsh areas of lower Mobile Bay (McCoy and Vogt 1985). Uses dense beds of aquatic vegetation for basking (NatureServe, 2015). Moderate ecological integrity tolerance ranges and site fidelity are inferred based on the species ability to inhabit Mobile bay, which is not pristine, and radio telemetry studies (NatureServe, 2015) which indicate individuals can move long distances (up to 17.9km) but most remain in the same vicinity they were tagged (inferred from NatureServe, 2015).

Dispersal/Migration

Motility/Mobility

Adult: High (NatureServe, 2015)

Migratory vs Non-migratory vs Seasonal Movements

Adult: Non-migratory (inferred from NatureServe, 2015)

Dispersal

Adult: Moderate (inferred from NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Nelson (1998) radiotagged 43 individuals on Gravine Island and tracked them from November, 1997 to October, 1998. Most remained in the vicinity of the Island, but others moved long distances. The researchers recorded straight-line movements as far as 17.9 km north (Negro Lake Basin) and 15.8 km south (Big Bay John) (NatureServe, 2015). Available literature does not indicate this species is migratory. Inferred as moderately able to disperse based on high mobility but information on dispersal is lacking.

Population Information and Trends

Population Trends:

Stable (USFWS, 2015)

Number of Populations:

10 (USFWS, 2021)

Population Size:

1000 to 10,000 (NatureServe, 2015)

Population Narrative:

NatureServe (2015) notes that the number of populations is between 1 and 5 and that these populations contain between 1,000 and 10,000 individuals. Moderate resiliency is inferred based on USFWS (2015) noting that trapping data indicates that populations are stable. Low representation and resiliency are inferred based on the low number of populations noted in NatureServe (2015).

Threats and Stressors

Stressor: Human Recreation (USFWS, 2015)
Exposure:
Response:
Consequence: Reduced nesting success
Narrative: Human disturbance on the major nesting area in the form of recreational use of the island (USFWS, 2015).

Stressor: Reduced aquatic vegetation (USFWS, 2015)
Exposure:
Response:
Consequence: Reduced food source
Narrative: Natural phenomena, such as the movement of saltwater wedges up into bays during hurricanes, were considered more likely sources of seasonal (temporary) reductions in vegetation. Periodic maintenance dredging, which currently occurs at the mouths of occupied channels in Mississippi, may also induce upstream movement of saltwater wedges and act to facilitate reductions in submerged aquatic vegetation (USFWS, 2015).

Stressor: Access to upland areas (USFWS, 2015)
Exposure:
Response:
Consequence: Reduced nesting habitat
Narrative: Rip-rap and bulkheads on riverbanks and edges of bayous restrict access to upland areas by nesting females (Leary et al. 2008) (USFWS, 2015).

Stressor: Incidental harvest (USFWS, 2015)
Exposure:
Response:
Consequence: Reduced numbers
Narrative: Incidental harvesting by commercial fishermen and shrimpers in gill, hoop, and trammel nets was also described as a threat under this factor in the final listing rule. This remains a potential threat to the species (Leary et al. 2008), although current state saltwater fishing regulations in Alabama and Mississippi are likely effective in limiting most incidental mortality (Alabama Department of Conservation and Natural Resources (ADCNR) 2015; Mississippi Department of Marine Resources (MDMR) 2013) (see Factor D.) (USFWS, 2015).

Stressor: Shooting (USFWS, 2015)
Exposure:
Response:
Consequence: Reduced numbers

Narrative: The shooting of basking or nesting turtles is considered a current threat (USFWS, 2015).

Stressor: Predation (USFWS, 2015)
Exposure:
Response:
Consequence: Reduced numbers
Narrative: Fish crows, alligators, armadillos and raccoons are listed as known predators of this species. Fire ants are listed as potential predators (USFWS, 2015).

Stressor: Water Quality (USFWS, 2015)
Exposure:
Response:
Consequence: Reduced food source
Narrative: An overall decline in water quality is thought to be the primary vector for the continued disappearance of submerged aquatic grasses (Moncreiff 2007) which provide food and habitat for the Alabama red-bellied turtle (USFWS, 2015).

Stressor: Roads (USFWS, 2015)
Exposure:
Response:
Consequence: Reduced numbers
Narrative: Roads near upland nesting sites are a threat to adult females and hatchlings. The U.S. Highway 90/98 causeway (Mobile Bay Causeway, Battleship Parkway) is an elevated roadbed constructed in the 1920s that crosses Mobile Bay and connects Baldwin and Mobile counties in Alabama (Godwin 2010). The aquatic habitat in this area supports an important population segment of the Alabama red-bellied turtle and due to the elevated nature of the roadbed, female turtles frequently attempt to nest in this area. Nelson and Scardamalia-Nelson (2014) have summarized the mortality data from 13 years of surveys of dead Alabama red-bellied turtles at this site. They documented 773 dead turtles that had been run over and killed on the causeway; these numbers are considered a minimum since it was unlikely all dead hatchlings were located. Most of the mortality was to hatchling turtles, but twenty-one percent of the mortality was of adult female turtles (USFWS, 2015).

Recovery

Reclassification Criteria:
Long-term protection has been established for three nesting habitats. This criterion has been partially met. Gravine Island, a known nesting site in Alabama, has been purchased by the U.S. Army Corps of Engineers and is protected as part of the Upper Delta Wildlife Management Area. Predation is still a major problem at Gravine Island; due to low juvenile recruitment, the site may function as a population sink (see discussion under Factor A., below). In Alabama and Mississippi, the overall distribution of nesting areas remains unknown. Nesting sites in Mississippi have been identified along the West Pascagoula River, along the Escatawpa River and at the Grand Bay National Estuarine Reserve (Reserve), however only the Reserve site is under public ownership and protection (USFWS, 2015).

Basking, feeding and overwintering habitats have been protected. This criterion has not been met. Some basking, feeding, and overwintering habitats have been identified in Alabama and Mississippi. We are still working to accomplish recovery plan tasks like 2.0 and 3.0. No specific areas have been targeted for protection to secure basking, feeding, and overwintering habitat for Alabama red-bellied turtles (USFWS, 2015).

Fifteen years of data demonstrate that the population trend is increasing. This criterion has not been met. Survey/monitoring studies have been conducted at varying intervals since the late 1970s in Alabama. Populations in Mississippi were largely unknown before the mid-1990s, and were not formally considered conspecific with those in Alabama until 2003 (Leary et al. 2003). Existing data do not support a population trend that is increasing (see discussion below under Biology and Habitat: Abundance, population trends) (USFWS, 2015).

Delisting Criteria:
(1) At least five (5) Alabama Red-bellied Turtle populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. Populations (as defined in criterion 1) must be distributed as described below to ensure adequate regional representation and intra-regional redundancy of resilient populations (addresses Factors A and E). (a) Three (3) of the five (5) populations must occur in Alabama. One (1) in the Lower Mobile-Tensaw Delta, one (1) in drainages on the west side of Mobile Bay, and one (1) in drainages on the east side of Mobile Bay. (b) Two (2) of the five (5) populations must occur in Mississippi. One (1) must be the Pascagoula River. (2) Conservation measures (e.g., habitat restoration, 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 Alabama Red-Bellied Turtle to remain viable into the foreseeable future (addresses Factor A and E). (3) Additional threats have been reduced or eliminated to the degree that the species will remain viable into the future (addresses Factor A, B, C, D, and E). (USFWS, 2019)

Recovery Actions:
- 1. Develop standardized protocols for Alabama Red-bellied Turtle surveys 2. Locate crucial habitats within the distribution of recovery populations that are used for basking, feeding, nesting, overwintering; and by small juveniles. 3. Implement a schedule of regular population and habitat surveys, at 5-year intervals, as part of a range-wide monitoring plan. 4. Identify threats to recovery populations and habitat. 5. Work with governmental and nongovernmental partners to determine the best methods to restore SAV beds for recovery populations. 6. Implement protections for basking, feeding, nesting, and overwintering habitats to remove threats to recovery populations. 7. Establish standardized methods for monitoring of populations and habitat conditions. 8. Determine population and habitat trends, at five-year intervals for Alabama Red-bellied Turtle recovery populations in Alabama and Mississippi. 9. Complete a genetic analysis to determine the discreteness between and among Alabama and Mississippi populations and to estimate effective population sizes. 10. Conduct research to develop a more complete understanding of biological and ecological factors that are limiting recovery. 11. Coordinate all recovery activities, evaluate success, and revise recovery plan as needed. (USFWS, 2019)

Conservation Measures and Best Management Practices:
- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Develop standardized protocols for Alabama red-bellied turtle surveys. 2. Locate crucial habitats within the distribution of recovery populations that

are used for basking, feeding, nesting, overwintering, and by small juveniles. 3. Implement a schedule of regular recovery population monitoring and suitable habitat surveys, at 5-year intervals, as part of a range-wide monitoring plan. a. Establish standardized methods for monitoring populations and habitat conditions b. Determine population and habitat trends 4. Identify threats to recovery populations and habitat. 5. Work with governmental and nongovernmental partners to determine the best methods to restore SAV beds for recovery populations. 6. Implement protections for basking, feeding, nesting, and overwintering habitats (including dispersal corridors) to remove threats to suitable habitat required necessary to recover populations. 7. Complete a genetic analysis to determine the discreteness between and among Alabama and Mississippi populations and to estimate effective population sizes. 8. Conduct research to develop a more complete understanding of biological and ecological factors that are limiting recovery. 9. Coordinate all recovery activities, evaluate success, and revise recovery plan as needed. (USFWS, 2021)

References

U.S. Fish and Wildlife Service. 1989. Alabama Red-bellied Turtle Recovery Plan. U.S. Fish and Wildlife Service, Jackson, Mississippi. 17 pp

U.S. Fish and Wildlife Service. 2015. Alabama Red-bellied Turtle (Pseudemys alabamensis) 5-Year Review: Summary and Evaluation U.S. Fish and Wildlife Service Southeast Region Mississippi Ecological Services Office Jackson, Mississippi

NatureServe Explorer (2015): An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://explorer.natureserve.org. (Accessed: March 21, 2016)

NatureServe Explorer (2015): An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://explorer.natureserve.org. (Accessed: March 21, 2016) . USFWS. 2021. Alabama Red-bellied Turtle (Pseudemys alabamensis) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service South Atlantic–Gulf and Mississippi Basin Regions Mississippi Ecological Services Field Office Jackson, Mississippi. 22 pp.

USFWS. 2019. Revised Recovery Plan for Alabama Red-bellied Turtle (Pseudemys alabamensis). Atlanta, Georgia. 7 pp.

USFWS. 2021. Alabama Red-bellied Turtle (Pseudemys alabamensis) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service South Atlantic–Gulf and Mississippi Basin Regions Mississippi Ecological Services Field Office Jackson, Mississippi. 22 pp.

SPECIES ACCOUNT: *Pseudemys rubriventris bangsi* (Plymouth Red-Bellied Turtle)

Species Taxonomic and Listing Information

Listing Status: Endangered; Northeast Region (R5) (USFWS, 2015)

Physical Description

The redbelly turtle, Pseudemys rubriventris, is a large basking turtle 10-12 inches (254- 305 mm) in carapace length when mature. Coloration and pattern are highly variable, but in general, the carapace is mahogany to black with light chestnut to reddish vertical bars on the laminae. The name rubriventris is from the Latin words rubidus for reddish, and venter for belly, referring to the reddish plastron (Graham 1991). Considerable sexual dimorphism exists in body size and scute proportions (Graham 1991). Female redbelly turtles are larger and have a longer plastron, higher shell, and wider bridge, and plastral scutes are relatively longer at the midline, except the femoral scute, which is slightly longer in males. Redbelly turtles, especially males, tend to become melanistic with age. Background color of the adult male plastron is pale pink overlaid with dark vermicular mottling; in females it is coral red with grey figures narrowly bordering the plates (Graham 1971b). The front of the upper jaw has a terminal notch flanked on each side by a distinct maxillary cusp. The presence of maxillary cusps distinguishes the redbelly group, which also includes the Florida redbelly turtle (P. nelsoni) and the Alabama redbelly turtle (P. alabamensis) (USFWS, 1994).

Taxonomy

The red-bellied cooter (Pseudemys rubriventris) was originally described by J. LeConte in 1830 as Testudo rubriventris based on a specimen that was collected near Trenton, New Jersey (Mitchell 1994). F. Lucas was the first to recognize the existence of these turtles within the State of Massachusetts in 1869 (USFWS 1994). By 1894, Lonnberg transferred the species to the geuns Pseudemys where it remains today (Mitchell 1994). Other scientific names previously applied to this species in the literature are Emys rubriventris, Ptchemys rugosa, Pseudemys rugosa, and Chrysemmys reubriventris (Mitchell 1994). Additional common names include Plymouth turtle, Plymouth terrapin, Plymouth red-bellied turtle, and Plymouth red-bellied terrapin (Schmidt 1953) (USFWS, 2007).

Current Range

Limited to about 17 ponds in and near the towns of Plymouth and Carver, Plymouth County, Massachusetts.

Critical Habitat Designated

Yes; 4/2/1980.

Legal Description

On April 2, 1980, the U.S. fish and Wildlife Service designated critical habitat for Pseudemys rubriventris bangsi pursuant to the Endangered Species Act of 1973, as amended (45 FR 21828 - 21833).

Critical Habitat Designation

Critical habitat for the Plymouth Red-Bellied Turtle is designated in Plymouth County, Masachusetts:

An area including Briggs Reservoir, Cooks Pond, Little South Pond, South Triangle Pond, Great South Pond, Powderhorn Pond, Boat Pond, Hoyte Pond, Gunners Exchange Pond, Crooked Pond and Island Pond as follows: Beginning at the intersection of the centerline of the right-of-way of the Boston Edison and New Bedford Gas and Edison Light Company transmission lines and the westerly right-of-way line of Long Pond Road, thence southeasterly, along the westerly rightof-way line of Long Pond Road, 10,370 feet to the intersection of the said rightof-way line and the boundary line of the Myles Standish State Forest: thence southerly and westerly, along the boundary line of the Myles Standish State Forest, crossing and re-crossing Snake Hill Road, 11.200 feet, more or less; thence westerly, leaving the boundary line of the State Forest, 1,530 feet, more or less, to the boundary line of the Myles Standish State Forest; thence westerly, along the boundary line of the Myles Standish State Forest, 9,180 feet, more or less, to the intersection of the boundary of the said State Forest and the easterly right-of-way line of the Algonquin Gas Transmission Company pipeline; thence northerly, along the easterly right-of-way line of the said pipeline, 6,223 feet, more or less, to the intersection of the easterly right-of-way line of the said pipeline and the northerly right-of-way line of Rings Pond Plain Road; thence northeasterly, along the northerly right-of-way line of said road 3,lUO feet to a point; thence northerly, 800 feet, more or less, to the sourtherly right-or-way line of the Boston Edison and new Bedford Gas and Edison Light Company transmission lines: thence northwesterly, along the southerly right-of-way base of the said transmission lines, 4,150 feet, more or ’ less, to the intersection of the southerly right-of-way line of the said transmission lines and the easterly right-of-way line of the Algonquin Gas Transmission Company pipeline; thence northerly, along the easterly right-of-way line of the said pipeline, 2,500 feet, more or less, to the intersection of the easterly right-of-way line of the said pipeline and the southerly right-of-way line of Black Cat Road; thence southeasterly, along the southerly right-of-way line of said road, crossing South Pond road and continuing southeasterly, along the southerly right-of-way line of an unnamed road, 10,370 feet, more or less, to a point; thence southerly 2,300 feet, more or less. to the northerly right-of-way line of the Boston Edison and New Bedford Gas and Edison Light Company transmission lines, thence easterly, along the northerly right-of-way line of the said transmission lines, 1,300 feet, more or l,ess, to the intersection of the northerly right-of-way line of the said transmission lines and the westerly right-of-way line of Long Pond Road; thence southerly, along the westerly right-of-way line of said road, 100 feet, more or less, the place of beginning.

Primary Constituent Elements/Physical or Biological Features

Not available

Special Management Considerations or Protections

Activities that may adversely modify critical habitat includes:

1. With regard to the Plymouth red-bellied turtle, a major threat to the continued existence of this Species is the adverse modification of the water quality and levels of the ponds on which it depends. Any tdgntficant alteration of the water levels, as by groundwater pumping, or reduction in water quality which would reduce or eliminate vegetation and aquatic prey items of this turtle could adversely modify critical Habitat since aquatic vegetation serves as both food and shelter to the turtle. Siltation resulting from land clearing adjacent to ponds or pollution of the groundwater could eliminate vegetation and aquatic invertebrates.

2. Because this species uses wetlands adjacent to the ponds, the draining of wetlands within the Critical Habitat could adversely affect the species.

3. Shoreline modification, filling, and dredging for beaches, dikes, real estate development or similar types of activity could be considered to adversely affect Critical Habitat since they could affect water quality, levels of shoreline, and nesting and overwintering sites for the species.

Life History

Feeding Narrative

Adult: Adults and large subadults apparently herbivorous (USFWS 1981). Also may consume crayfish and other small aquatic animals (Matthews and Moseley 1990).; Food Habits: Carnivore (Adult, Immature), Piscivore (Adult, Immature), Invertivore (Adult, Immature), Herbivore (Adult, Immature)Active from late March to October (USFWS 1981). Spends much of day basking.; (NatureServe, 2015)

Reproduction Narrative

Adult: The microclimate at redbelly turtle nests can affect the sex ratio of hatchlings (temperature dependent sex determination or TSD). Cool nests will produce more males and warm nests more females (USFWS, 1994). Lays clutch(es) of about 10-17 eggs in June-July. Eggs hatch in 73-80 days; hatchlings may overwinter in nest and emerge in spring. Females are sexually mature in 8-15 years (Matthews and Moseley 1990).; (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits deep, permanent ponds with nearby sandy areas for nesting; surrounding vegetation consists of pine barrens or mixed deciduous forest. Wanders on land, fall and spring. Inactive at pond bottom in winter. Eggs are laid in nests dug in soft soil in open areas usually within 100 yards of water (USFWS 1981). Often nests in tilled or disturbed soil (DeGraaf and Rudis 1983, Ernst and Barbour 1972). Burrowing in or using soil (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat needs of this species and the limited number of known locations.

Dispersal/Migration

Motility/Mobility

Adult: Moderate (NatureServe, 2015)

Migratory vs Non-migratory vs Seasonal Movements

Adult: Nonmigratory(NatureServe, 2015)

Dispersal

Adult: Low (NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Nonmigrant (NatureServe, 2015). dispersal rates of headstarted turtles and non-headstarted juveniles from natal ponds appears to be very low (USFWS, 1994).

Population Information and Trends

Population Trends:

Unknown

Number of Populations:

43 AUs (USFWS, 2022)

Population Size:

~1,950 (USFWS, 2022)

Population Narrative:

Total population size was estimated at about 200 breeding individuals in 1985; about 100 young (reared from artificially incubated eggs) were added to the population each year beginning in 1987. In 1993, USFWS (Federal Register, 29 July 1993) stated that the population was "300-400 turtles." Clough (2001, Endangered Species Bulletin 25(4):27) reported the population size as 300 adults. Occurs in about 17 ponds. (NatureServe, 2015). A study conducted from 2014 to 2016 in a portion of the species' range within Plymouth County estimated that there were 933 individuals distributed across 7 subpopulations within the study area, excluding recent headstarts released from 2013 to 2016 (Regosin et al. 2017, p. 25). The 2021 SSA report assessed 43 analysis units (AUs), consisting of occupied water bodies where northern red-bellied cooters have been observed or where headstarted hatchlings have been released, and estimated an overall current population of around 1,950 individuals within the species' entire range in Massachusetts (USFWS, 2022).

Threats and Stressors

Stressor: Residential development (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Residential development is listed as a threat to this species (USFWS, 2007).

Stressor: Agricultural development (USFWS, 2007)
Exposure:

Response:
Consequence: Loss of habitat
Narrative: Cranberry production (water use) is a threat to this species (USFWS, 2007).

Stressor: Fire supression (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habiat
Narrative: Fires once set to control forest succession also created excellent nesting areas for this species. Recent fire suppression cause ponds to become surrounded by forest (USFWS, 2007).

Stressor: Predation (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Predation of newly emerged cooters by the bullfrog, as well as raccoons (eggs and newly hatched), herons and bass is a threat to this species (USFWS, 2007).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Inadequacy of existing regulatory mechanisms is listed as a threat to this species (USFWS, 2007)

Stressor: Climate change (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat/competition
Narrative: Warmer weather in spring and summer may provide more favorable conditions for Massachusetts turtles to basek, feed and nest. Hatching success (absent predation) may be higher during warmer summers and a more equal sex ratio of hatchlings could result. On the other hand, the ranges of other species will be similarly influenced to some degree and new competitors, pathogens, and introduced invasive species (e.g. and aquatic plant that outcompetes native cooter foods) could become established (USFWS, 2007).

Stressor: Road Mortality (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Road mortality in fragmented landscapes is a major threat facing some turtle populations. Road mortality or injury of northern red-bellied cooters from vehicle collisions has been documented in recent years (USFWS 2021, pp. 19-20). Adult mortality, particularly of female turtles making overland movements in search of nest sites, has the potential to lead to male biased populations, decreased reproductive output, and decreased juvenile recruitment. Increased habitat fragmentation, road densities, or traffic volume may increase the potential for road mortality to impact population viability in the future (USFWS, 2022).

Recovery

Reclassification Criteria:
Reclassification to threatened status will be considered when: the Plymouth redbelly turtle (cooter) population level of approximately 300 breeding-age individuals to a total of 600 breeding-age individuals distributed among a minimum of 15 self-sustaining populations (USFWS, 2007).

Recovery Priority Number: 9

Delisting Criteria:
The distribution of the species is expanded to 20 or more self-sustaining populations (in lakes, ponds, and possibly rivers) and numbers are increased to a total of 1,000 or more breeding age individuals (USFWS, 2007).

Sufficient habitat is protected to allow long-term maintenance of the populations (USFWS, 2007).

Knowledge about their life history, habitat requirements, and limiting factors is sufficient to effectively protect and manage the turtles and their habitat (USFWS, 2007).

Recovery Actions:
- Protection through fee acquisition, conservation easement, purchase of development rights or any other means, the most important pond shore habitats supporting the species in Plymouth County (USFWS, 2007).
- Conduct population estimate surveys of selected ponds and rivers, such as Federal Pond Assawompsett Pond, East Head Pond, Great South Pond, Hoyts-Gunners Exchange Pond, Island Pond, Sampson Pond, and the Nemasket and Weweantic Rivers. These waters are likely to support the greatest number of cooters in the Massachusetts population and have not been recently surveyed (USFWS, 2007).
- Prioritize and conduct basking site and nest site enhancement activities at ponds supporting the largest cooter populations (USFWS, 2007).
- Utilize the survival data provided in Table 2 to review the number of released turtles through the HS program and supplement selected ponds as appropriate (USFWS, 2007).
- Conduct research and identify if feasible means to mitigate high nest/egg and hatchling predation rates can be implemented (USFWS, 2007).
- Develop a monitoring plan what will efficiently track the status of the population both during the process of recovery and post-delisting (USFWS, 2007).

Conservation Measures and Best Management Practices:
- RECOMMENDATIONS FOR FUTURE ACTIONS • Continue working with conservation partners on land protection, particularly of nesting habitat and areas where habitat connectivity is important. Protection of known nesting areas should be prioritized. • Increase outreach to landowners to increase land protection and habitat restoration efforts where appropriate. • Consider nest site restoration or creation in priority areas where nesting areas have not been identified or where known nest areas present long-term or persistent management concerns, such as proximity to roads, risk of collection, or increased risk of predation. • Manage basking habitat in priority aquatic

habitat where basking objects are limited. • Continue to proactively identify new occupied waterbodies and monitor known sites via use of qualified personnel and grant programs to monitor existing populations, evaluate whether headstart-only populations are reproducing successfully, and assess sites where limited information is available about northern red-bellied cooter status. Continue to identify nesting areas that have not yet been located. • Evaluate the extent of interpond movements in multipond AUs or between AUs where existing information about turtle movement is not available. Identify areas where road crossings or other barriers to connectivity exist and determine whether there are feasible means to mitigate these threats or barriers. • Conduct research and monitoring on demographics, genetics, and metapopulation dynamics. • Develop guidance and best management practices for various activities that may affect northern red-bellied cooters to support avoidance and minimization of adverse impacts. • Collaborate with MassWildlife, the Eastern Massachusetts National Wildlife Refuge Complex, and other partners to evaluate the northern red-bellied cooter headstart program and develop a strategy for implementing the program in the future so that release sites are targeted based on program goals. Consider opportunities to evaluate the demographic trend of subpopulations without headstart inputs by pausing release of headstarts at some ponds. • Examine the significance of shallow vegetated coves for juvenile northern red-bellied cooters. • Seek additional information about threats evaluated in the SSA, particularly concerning threats for which limited information was available or for which information was available only for some occupied waterbodies. Support additional research to assess how factors influencing viability might impact the northern red-bellied cooter in the future. • Document and monitor winter kill events and conduct research on what factors might lead to these conditions, including possible anoxic conditions that may be caused by an overabundance of aquatic plants. • Continue to implement nest protection and perform predator control, where possible. Conduct research and identify if feasible means to mitigate high nest/egg and hatchling predation rates can be implemented as alternatives to the headstart program. • Update the Recovery Plan, including re-evaluating the recovery criteria. • Develop a monitoring plan that will efficiently track the status of the population both during the process of recovery and post-delisting. • Monitor collection and the illegal trade in turtles as a potential future threat and proactively protect sensitive location information (USFWS, 2022).

References

U.S. Fish and Wildlife Service. 1994. Plymouth Redbelly Turtle (Pseudemys rubriventris) Recovery Plan, Second Revision. Hadley, Massachusetts. 48 pp.

U.S. Fish and Wildlife Service. 2007. Northern Red-bellied Cooter (Pseudemys rubriventris) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service New England Field Office Concord, New Hampshire

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

U.S. Fish and Wildlife Service. 1980. Endangered and Threatened Wildlife and Plants

Listing as Endangered With Critical Habitat for the Plymouth Red-Bellied Turtle In Massachusetts. Final rule. 45 FR 21828 - 21833 (April 2, 1980).

U.S. Fish and Wildlife Service. 1994. Plymouth Redbelly Turtle (Pseudernys rub,~ventris) Recovery Plan, Second Revision. Hadley, Massachusetts. 48 pp

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A." USFWS. 2022. Northern Red-bellied Cooter Massachusetts Population (Pseudemys rubriventris) 5-Year Review: Summary and Evaluation. USFWS. New England Field Office. North Atlantic-Appalachian Region. Concord, NH. 13 pages.

USFWS. 2022. Northern Red-bellied Cooter Massachusetts Population (Pseudemys rubriventris) 5-Year Review: Summary and Evaluation. USFWS. New England Field Office. North Atlantic-Appalachian Region. Concord, NH. 13 pages.

U.S. Fish and Wildlife Service. 2007. Northern Red-bellied Cooter (Pseudemys rubriventris) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service New England Field Office, Concord, New Hampshire

SPECIES ACCOUNT: *Sceloporus arenicolus* (Dunes sagebrush lizard)

Species Taxonomic and Listing Information

Listing Status: Endangered

Physical Description

The DSL is a small, light brown spiny lizard with a maximum snout-to-vent length (SVL) of 70 millimeters (mm) (2.8 inches[in]) (Figure 2-1; Degenhardt et al. 1996, p. 159; Hibbitts and Hibbitts 2015, p. 155). Its dorsal color matches that of sand and varies from a light tan to reddish tan. It also has grayish dorsolateral stripes (Hibbitts and Hibbitts 2015, p. 155). Females average 53.8 mm (2.12 in) SVL, whereas males average 54.5 mm (2.15 in) SVL (Degenhardt et al. 1996, p. 159). During breeding, females develop patches of orange along their head, neck, body, and tails, whereas males have paired blue patches on their belly (Figure 2-2; Degenhardt et al. 1996, p. 159; Hibbitts and Hibbitts 2015, p. 155). Individual DSL have 41-52 scale rows around the midbody, granular scales on the back of its thighs, and more than 9 scale rows separating its femoral pores (i.e., small pores located on the ventral scales of the hind legs) (Hibbitts and Hibbitts 2015, p. 156). The DSL can be distinguished from a similar co-occurring species, the prairie lizard (S. consobrinus), by the presence of more than eight scales between the femoral pores (USFWS, 2024).

Taxonomy

The DSL belongs to the family Phrynosomatidae, a diverse group of lizards with 7 genera and 22 species in New Mexico (Degenhardt et al.1996, p. 138; Stuart et al. 2019, entire), and 6 genera and 18 species in Texas (iNaturalist 2020, unpaginated). The DSL is in the genus Sceloporus, which are the spiny lizards. The species etymology is after the Latin noun “arena” meaning sand, and adjective “-cola” meaning dweller, referring to the habitat where the species lives (Reptile Database 2020, p. 1). The currently accepted classification is (Integrated Taxonomic Information System 2018): Phylum: Chordata Class: Reptilia Order: Squamata Family: Phrynosomatidae Genus: Sceloporus Species: arenicolus (USFWS, 2024).

Historical Range

The range of the DSL is limited to the shinnery oak duneland and shrubland landscapes in southeastern New Mexico and in western Texas, within an elevational range of 780-1400 meters (Painter et al. 1999, p. 1). Historically, it is estimated that the shinnery oak duneland and shrubland landscape covered 477,520 hectares (ha) (1,179,980 acres[ac]) in New Mexico and 398,583 ha (984,920 ac) in Texas (Figure 2-3). However, within this landscape the DSL’s distribution is naturally patchy and fragmented (Fitzgerald et al. 1997, p. 28) and the species is primarily associated with sand dune blowouts that occur within active sand dunes dominated by shinnery oak (Quercus havardii) and scattered sandsage (Artemisia filifolia) (see Section 2.6). DSL habitat is fragmented by both anthropogenic development and natural landscape barriers (USFWS, 2024).

Current Range

The range of the DSL is limited to the shinnery oak duneland and shrubland landscapes in southeastern New Mexico and in western Texas, within an elevational range of 780-1400 meters (Painter et al. 1999, p. 1). Historically, it is estimated that the shinnery oak duneland and shrubland landscape covered 477,520 hectares (ha) (1,179,980 acres[ac]) in New Mexico and

398,583 ha (984,920 ac) in Texas (Figure 2-3). However, within this landscape the DSL's distribution is naturally patchy and fragmented (Fitzgerald et al. 1997, p. 28) and the species is primarily associated with sand dune blowouts that occur within active sand dunes dominated by shinnery oak (Quercus havardii) and scattered sandsage (Artemisia filifolia) (see Section 2.6). DSL habitat is fragmented by both anthropogenic development and natural landscape barriers (USFWS, 2024).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food Source

Adult: The DSL is a sit-and-wait ambush forager and feeds on a variety of terrestrial invertebrates, including ants and their pupae, small beetles and their larvae, crickets, grasshoppers, and spiders (USFWS, 2024).

Reproductive Strategy

Adult: Oviparity

Lifespan

Adult: 2 to 4 years (USFWS, 2024)

Breeding Season

Adult: June-August (USFWS, 2024)

Reproduction Narrative

Adult: DSL have a short lifespan, living only 2 to 4 years (Figure 2-4; Snell et al. 1997, p. 9; Fitzgerald and Painter 2009, p. 200), with a maximum reported age of 5 years (Leavitt and Acre 2021, p. 48). They have a reduced reproductive output compared to other Sceloporines, reproducing only once or twice in a season (Snell et al. 1997, p. 10; Ryberg et al. 2012, p. 583). They are active from April through October and dormant underground during the colder winter months (Sena 1985, p. 19, Sartorius et al. 2002, p. 1970; Painter 2004, p. 2; Ferguson et al. 2014, p. 60). Sexually mature males emerge in April (Sena 1985, p. 29), vitellogenesis (i.e., internal egg development) in females begins in late April (Sena 1985, p. 27), and mating occurs from May to early July (Fitzgerald and Painter 2009, p. 200; Hibbitts and Hibbitts 2015, p. 156). Males are territorial and compete for females, whereas females are not territorial and have overlapping home ranges (Fitzgerald and Painter 2009, p. 200). Females lay one or two clutches of eggs annually, usually between June and August (Degenhardt and Jones 1972, p. 216; Cole 1975, p. 292; Fitzgerald and Painter 2009, p. 200; Hibbitts and Hibbitts 2015, p. 156). Clutches contain an average of five eggs (range three to six) and are laid underground in sand dunes dominated by shinnery oak (Hibbitts and Hibbitts 2015, p. 156, Hill and Fitzgerald 2007, p. 30; Ryberg et al. 2012, p. 583). The DSL has the smallest clutch size compared to other sympatric phrynosomatid lizards, with a potential lifetime reproductive output of between 6 and 20 eggs (Sena 1985, p. 6; Snell et al. 1997, p. 10; Hill and Fitzgerald 2007, p. 2). By comparison, females of the common side-blotched lizard (Uta stansburiana), a habitat generalist that is sympatric with the DSL, lay one to seven clutches of one to eight eggs annually, usually between March through August (USFWS, 2024).

Habitat Type

Adult: Sand hills/Shinnery Oaks

Environmental Specificity

Adult: Narrow/specialist

Site Fidelity

Adult: High

Habitat Narrative

Adult: The Mescalero and Monahans Sandhills ecosystems, located in southeastern New Mexico and adjacent West Texas, are composed of ancient sand dune fields maintained by wind, moving sand, and partially stabilized by shinnery oak (as referenced in Walkup et al. 2017, p. 2). These ecosystems are characterized by a patchy arrangement of narrow, almost linear sand dunes embedded in a matrix of shinnery oak shrubland flats (Figure 2-6; Fitzgerald and Painter 2009, p. 199, Ryberg et al. 2015, p. 890). Within the sand dunes themselves, open dune blowouts (bowlshaped depressions) form when disturbance removes stabilizing vegetation. There are complex feedbacks between wind, sand, and shinnery oak that make this a “unique, irreplaceable landform” (Ryberg et al. 2015, pp. 888, 893). The DSL is considered a habitat specialist due to its restricted range and dependence on shinnery oak duneland habitat (Fitzgerald et al. 1997, p. 4; Hibbitts et al. 2013, p. 104; Hardy et al. 2018, p. 10, Fitzgerald et al. 2022, p. 6). Within the duneland complexes, the DSL further selects for areas with open dune blowouts and uses the interface of the shinnery oak and sand (Walkup et al. 2021, pp. 13-14; Walkup et al. 2022, pp. 350, 352, 356). The DSL will traverse other habitats, such as shinnery oak shrublands (flats), open dunes, and barren sand areas, when such habitats are in contact with, or embedded within, the shinnery oak duneland landscape (USFWS, 2024).

Dispersal/Migration

Dispersal

Adult: Medium

Dispersal/Migration Narrative

Adult: DSL movement includes dispersal of individuals from their birth site to their breeding site, as well as from one breeding site to another. Patterns of movement in DSL involve both the movements of juveniles and adults; however, data on DSL dispersal is limited, especially for juveniles (Painter et al. 1999, p. 37). Monitoring of pitfall traps (Painter and Fitzgerald, unpublished data, cited in Painter 2004, p. 5) indicate that interdune, shinnery oak flats (i.e., shinnery oak shrublands) that are at least 500 m (1,640 ft) wide and less than 2,000 m (6,562 ft) from occupied duneland habitat, are important as dispersal corridors for juveniles and for females seeking egg deposition sites (Fitzgerald et al. 1997, Appendix II; Painter 2004, p. 5; Johnson et al. 2016, p. 39; TAMU 2016, p. 2). Some females may leave their normal home range to nest in other dune blowouts (Fitzgerald et al. 2005, p. 12). One gravid female tracked with radio telemetry moved approximately 200 m (656 ft) through shinnery oak habitat to other dune blowouts (Fitzgerald et al. 2005, p. 11). It returned to the original capture site after it moved; thus, its movement was probably for egg laying. Another study found one gravid female moved greater than 150 m (492 ft) (Fitzgerald et al. 2005, p. 12). A third study documented a longdistance dispersal during a pitfall trapping study when a marked individual moved between trapping grids (843 m [2,766 ft]) in which the direct route would have required moving through shinnery oak shrublands and across a singular dirt (caliche) road (Leavitt et al. 2011 p. 8). However, no other similar long-distance dispersal events have been described with radio telemetry methods (USFWS, 2024).

Population Information and Trends

Population Trends:

An analysis by Johnson et al. (2016, p. 38) suggested that in New Mexico DSL numbers have declined in areas with decreased habitat quality, and Leavitt and Hill (2020, entire; Acre and Hill 2023, p. 11) also note that some high-quality habitat locations that formerly had high DSL abundance are now showing declining DSL numbers. More recently, Leavitt and Acre (2021, entire) used trapping data to estimate DSL densities in relation to environmental variables and then extrapolate population totals for the New Mexico portion of the range (Figure 2-11). They estimated a population size of 1,015,945 individual DSL with the 95 percent confidence interval ranging from 225,766 to 4,363,797 individuals (Table 2-1). Densities were predicted to be highest in the North Mescalero 3 and 5 Analysis Units (USFWS, 2024).

Resiliency:

Our assessment suggests that a small portion (6 percent) of the overall DSL range is in high enough condition to support robust, highly viable populations. This is not surprising as our geospatial analysis revealed that less than half of the DSL range is considered Minimally Disturbed by human development. There are large portions of the range and even an entire Representation Unit (Southern Mescalero) that we assessed as unlikely to support viable populations of the DSL. Since our assessment is based on habitat, we acknowledge that even these Low condition areas likely support DSL populations. However, we expect that those populations are likely reduced, have limited recruitment and higher mortality, and are disconnected from each other. As indicated by estimates of genetic effective size (Table 2-2), several of these highly modified Analysis Units have effective sizes below thresholds recommended to maintain long-term genetic health (Chan pers. comm. 2023; Hoban et al. 2023, entire). The long-term viability of the DSL depends on having interconnected habitat patches in which populations shift around the landscape. Highly disturbed, highly fragmented areas are unable to support this requirement (USFWS, 2024).

Representation:

All Analysis Units and Representation Units are extant, and we are unaware of any significant range reductions, meaning that the phylogenetic lineages identified by Chan et al. (2020, entire) are still represented. The mere existence of these lineages on the landscape suggests there is still raw genetic variation present within the species that can support adaptive capacity. However, some Representation Units are composed of populations with low resiliency. Both Analysis Units in the Southern Mescalero are in Low condition. The low viability of these units suggests that an entire phylogenetic lineage is currently at high risk for extirpation. Two of the four Analysis Units in Monahans are also in Low condition. Importantly, these two units cover the northern and southern extremes of the DSL range in the Monahans Sandhills. Loss of these Analysis Units could result in the loss of genetic variation associated with extremes in the environmental variation experienced by the species in Monahans, reducing adaptive capacity. In fact, a general pattern is that Analysis Units are in better condition in the northern part of the species range (N. Mescalero). Southern populations experience higher temperatures and drier conditions (See Chapter 3) and may have higher capacity to withstanding climate change. However, their poor current condition limits their potential to contribute to long-term adaptation of the species (USFWS, 2024).

Redundancy:

All 11 Analysis Units have some DSL habitat classified as Minimally Disturbed, meaning they support some level of DSL populations. Given the size of the range, it is unlikely that a single catastrophe would eliminate the entire species. The resiliency scores of some Analysis Units, however, suggests that they are potentially vulnerable to extirpation. Loss of the Low condition Analysis Units would reduce the total number to 7, with those remaining concentrated in North Mescalero. It is a vulnerability that the Analysis Units in the strongest condition are clustered geographically: North Mescalero also includes some of the smallest units. An extreme event centered in that area could reduce abundance in the last strongholds for the species, leaving its viability tied to Low condition areas in Southern Mescalero and Monahans (USFWS, 2024).

Number of Populations:

11 Population Units 2 Representation Units (with separate analysis units in each). N Mescalero N Mescelaro 1, 236,687 estimated # of individuals N Mescelaro 2, 6,851 estimated # of individuals N Mescelaro 3, 117,158 estimated # of individuals N Mescelaro 4, 20,887 estimated # of individuals N Mescelaro 5, 284,084 estimated # of individuals S Mescalero. S Mescalero 1, 317,513 estimated # of individuals S Mescalero 2, 32,765 estimated # of individuals Monahans 1 Monahans 2 Monahans 3 Monahans 4

Population Size:

New Mexico portion of the range (Figure 2-11). They estimated a population size of 1,015,945 individual

Population Narrative:

More recently, Leavitt and Acre (2021, entire) used trapping data to estimate DSL densities in relation to environmental variables and then extrapolate population totals for the New Mexico portion of the range (Figure 2-11). They estimated a population size of 1,015,945 individual DSL with the 95 percent confidence interval ranging from 225,766 to 4,363,797 individuals (Table 2-1). Densities were predicted to be highest in the North Mescalero 3 and 5 Analysis Units.

Threats and Stressors

Stressor: Oil and Gas Development
Exposure:
Response:
Consequence:
Narrative: Currently, 70 percent of land within the New Mexico range of the DSL has been leased by private entities, the BLM, or the New Mexico State Land Office (NMSLO) for oil and gas exploration and development. Seventy-one percent of the mineral rights within the range of the DSL in New Mexico are federally owned and fall under BLM lease stipulations and the Pecos District (New Mexico) Special Status Species Resource Management Plan Amendment (RMPA). In

Texas, over 50 percent of oil production occurs in Districts 8 and 8A (Texas oil and gas districts); these districts overlap the known geographic range of the DSL (USFWS, 2024).

Stressor: Sand Mining
Exposure:
Response:
Consequence:
Narrative: It is estimated that current frac sand capacity is about 40 percent of total demand. It is thus expected to grow by 50 percent by 2023 and that more than 30 potential facilities could currently be identified (Mace 2019, p. 42). Given these estimates, our depiction of 18 mines modeled into the future, with no additional mines included, is a conservative approach even if few or no future sand mines impact DSL habitat (USFWS, 2024).

Stressor: Herbicide Treatment
Exposure:
Response:
Consequence:
Narrative: As discussed in Chapter 4, areas in the DSL range have been treated with herbicides in the past, particularly tebuthiuron, to eradicate shinnery oak. Currently tebuthiuron is not used extensively, but past use occurred across large areas in New Mexico and Texas including within the DSL range. Eradication of shinnery oak via tebuthiuron results in a type conversion of the habitat to one dominated by grasses, and DSL abundance is substantially lower in areas that have been treated (Snell et al. 1994, pp. 10-11). Therefore, for our purpose of categorizing suitable DSL habitat, we considered any areas that have been treated with tebuthiuron in the past to be Degraded (USFWS, 2024).

Stressor: Grazing
Exposure:
Response:
Consequence:
Narrative: The primary issue with livestock grazing is that shinnery oak is not ideal forage for cattle, therefore shinnery oak is often removed to encourage growth of better forage (Peterson and Boyd 1998, p. 24). There is little research on the effects grazing has on the DSL, though it has been found in areas of moderate grazing (Painter et al. 1999, p. 32). Heavy grazing may result in extensive open sand dunes, which lack the shinnery oak the DSL uses for shelter (Painter et al. 1999 p. 32). Shinnery oak duneland provide for poor agriculture and are not suitable for long term heavy grazing because it can destabilize dunes (Dhillion and Mills 2009, p. 271). Grazing does occur across the range of the DSL. If grazing causes the destabilization of dunes, it is unlikely those sand dunes will self-regenerate, therefore posing a threat to the species (USFWS, 2024).

Stressor: Off-Highway Vehicle Use
Exposure:
Response:
Consequence:
Narrative: Off-highway vehicles (OHVs), or off-road vehicles, include any vehicle that is used to travel on or immediately over land and natural terrain. This can include motorcycles, motor bikes, allterrain vehicles, dune buggies, snowmobiles, four-wheel drive vehicles, and any other vehicle designed for off-road travel (Ouren et al. 2007, p. 4). OHVs were identified as a threat to

the DSL by Painter (2004, p. 6) due to impacts on habitat and the potential for direct mortality. In other dune systems, OHVs have been shown to cause loss of vegetation due to direct mortality and compacted soils (Ouren et al. 2007, p. 11; Brodhead and Godfrey 1977, p. 306; Luckenbach and Bury 1983 p. 280). Arthropod diversity and abundance significantly decline in areas with OHV use, likely due to the loss or decline in habitat quality (Van Dam and Van Dam 2008, p. 416; Luckenbach and Bury 1983, pp. 275-276). Similarly, lizard diversity and abundance also decline in areas with OHV use, likely due to lower habitat quality and a reduction in the prey base (Bury et al. 1977, p. 16; Luckenbach and Bury 1983, p. 272). When compared to OHV impacted sites, undisturbed sites were found to support 1.8 times more lizard species, 3.5 times more individuals, and 5.9 times more biomass (Bury et al. 1977, p. 13). Tracks created by OHVs can fragment once continuous habitat, disrupting movement, dispersal, and genetic exchange of wildlife species (Ouren et al. 2007, p. 17). Direct mortality of lizards is frequently observed in areas of OHV use, along with much higher tail loss and a risk of crushing burrows (USFWS, 2024).

Stressor: Oil Spills
Exposure:
Response:
Consequence:
Narrative: Due to the large amount of oil and gas activities throughout the DSL range, the possibility of an oil spill must be addressed. Studies of other lizard species have shown that carcinogenic polycyclic aromatic hydrocarbons, a group of chemicals formed during incomplete burning of oil and gas, can accumulate in lizards and the ants they consume (Al-Hashem et al. 2007, pp. 552, 554-555). The accumulation of pollutants in lizards can cause severe organ pathology, resulting in decreased fitness (Al-Hashem 2011, p. 1394-1395). Oil pollution can also cause behavioral effects. Oil can darken substrate and cause lizards to emerge earlier because the substrate warms faster due to its darker color (Al-Hashem et al. 2007, p. 592). Oil pollution can have long lasting, chronic effects on wildlife (Al-Hashem 2011, p. 1395; Esler et al. 2018, p. 41; Rosell-Mele et al. 2018, p. 1017). The DSL has a limited, heavily disturbed range; an oil spill could degrade more habitat and restrict the range further. However, the impacts are likely to be localized to the location of a spill. Given the stochastic nature of a spill, it would be difficult to predict the likelihood and scale of such an event. Most likely, the frequency of spills is correlated with the extent of oil production and transportation (USFWS, 2024).

Recovery

Conservation Measures and Best Management Practices:
-

Additional Threshold Information:
-
-

References

USFWS. 2024. Species status assessment for the dunes sagebrush lizard. Version 1.3.

SPECIES ACCOUNT: *Sistrurus catenatus* (Eastern massassauga rattlesnake)

Species Taxonomic and Listing Information

Listing Status: Threatened; 09/30/2016; Great Lakes-Big Rivers Region (R3) (USFWS, 2016a)

Physical Description

The eastern massasauga rattlesnake is a small, heavy-bodied snake with a heart-shaped head and vertical pupils. The average length of an adult is approximately 0.6 meters (two feet). Adult eastern massasaugas are gray or light brown with large, light-edged chocolate brown blotches on the back and smaller blotches on the sides. The snake's belly is marbled dark gray or black and there is a narrow, white stripe on its head. Its tail has several dark brown rings and is tipped by gray-yellow horny rattles. Young snakes have the same markings as adults, but are paler than adults, and the rattle is represented by a single terminal segment called a button.

Taxonomy

The eastern massasauga rattlesnake, described by Rafinesque in 1818, has a variety of common names: eastern massasauga rattlesnake, eastern massasauga, prairie rattlesnake, spotted rattler, and swamp rattler (Gloyd 1940, p. 44; Minton 1972, p. 315). The U.S. Fish and Wildlife Service previously recognized the eastern massasauga rattlesnake as a subspecies (Sistrurus catenatus catenatus) of a wider ranging species (Sistrurus catenatus). Due to recently published scientific information on the phylogenetic relationships of the massasaugas we now recognize the eastern massasauga rattlesnake as a distinct species (Sistrurus catenatus). The Service revised the range of the eastern massasauga rattlesnake to the states of New York, Pennsylvania, Ohio, Michigan, Indiana, Illinois, Wisconsin, Minnesota, the eastern half of Iowa, and the Canadian province of Ontario. Extant populations in Missouri and southwest Iowa, previously thought to be included in the eastern massasauga range, no longer are considered to include the eastern massasauga rattlesnake. Massasaugas in those two areas are now understood to be the western massasauga subspecies.

Historical Range

Canada and U.S. (states of Illinois, Indiana, Iowa, Michigan, Minnesota, New York, Ohio, Pennsylvania, Wisconsin). The historic range of the eastern massasauga rattlesnake included sections of western New York, western Pennsylvania, southeastern Ontario, the lower peninsula of Michigan, the northern two thirds of Ohio and Indiana, the northern three quarters of Illinois, the southern half of Wisconsin, extreme southeast Minnesota, and the eastern third of Iowa.

Current Range

Canada and U.S. (states of Illinois, Indiana, Iowa, Michigan, Minnesota (?), New York, Ohio, Pennsylvania, Wisconsin). Although the limits of the current range of the eastern massasauga rattlesnake resemble the boundaries of its historic range, the geographic distribution has been restricted by the loss of the populations from much of the area within the boundaries of that range. The eastern massasauga is probably extirpated from Minnesota (USFWS 1998, p. 7). Rangewide, approximately 40 percent of the counties that were historically occupied by eastern massasauga no longer support the species. The eastern massasauga is currently listed as endangered or threatened in every state or province where it occurs except for Michigan, where it is designated as a species of special concern (USFWS 1998). Across the species range there has been no significant change in spatial distribution or number of populations since 2016. The EMR is extirpated in Missouri. No change (Crabill 2021). The EMR is extirpated in Minnesota. No change (Marsh 2021). (USFWS, 2021a)

Distinct Population Segments Defined

None. However,in the 1998 status assessment, the eastern massasauga rattlesnake was considered a distinct population segment of the wider ranging massasauga rattlesnake. However, since the DPS almost completely overlaid the range of the previously recognized subspecies, we treated this entity as a subspecies in subsequent assessments and Candidate Notices of Review. Recognition of the distinct population segment is no longer warranted because the range of the eastern massasauga rattlesnake no longer includes extant massasauga populations in Missouri and extreme southwest Iowa. These populations were included in the eastern massasauga DPS because they were of uncertain taxonomic status (USFWS 1998, p. 1-3).

Critical Habitat Designated

No; 9/30/2016.

Legal Description

Under the Act, a species may warrant protection through listing if it is endangered or threatened throughout all or a significant portion of its range. Listing a species as an endangered species or threatened species can only be completed by issuing a rule. Additionally, under the Act, critical habitat shall be designated, to the maximum extent prudent and determinable, for any species determined to be an endangered species or threatened species under the Act. We have determined that designating critical habitat is not prudent for the eastern massasauga rattlesnake due to an increased risk of collection and persecution. (USFWS, 2016)

Life History

Feeding Narrative

Adult: The eastern massasaugas is a carnivore/invertivore. Small mammals (voles, deermice, shrews) dominate the diet of the eastern massasaugas, with snakes and birds of lesser importance (Keenlyne and Beer 1973; Hallock 1991; Ernst 1992; Anton, in Johnson and Menzies 1993). In Missouri, massasaugas are known to feed mainly on rodents and snakes (Seigel 1986). These snakes also sometimes eat other small animals, and there is one report of consumption of bird (bobwhite) eggs (Applegate, 1995, Herpetol. Rev. 26:206). In Illinois, prey recovered from free-ranging neonates consisted primarily of southern short-tailed shrews (Blarina carolinensis). In feeding trials, neonates demonstrated a preference for snake prey, disinterest in anuran and insect prey, and indifference toward mammal prey (Shepard et al. 2004). Activity is often diurnal in spring and fall, more nocturnal-crepuscular in hot summer weather; the species is mainly diurnal in Pennsylvania, where most activity occurs between 0900 and 1500 hours (Reinert, cited by Ernst 1992). In the north-central part of the range, most activity occurs from about April to October or November; cold weather enforces inactivity. In Missouri, massasaugas are most active from April to mid-May and in October (Seigel 1986).

Reproduction Narrative

Adult: Early reports were unclear or speculative with regard to the timing of mating. For example, Crawford (1936, pp. 49-50) speculated mating occurred upon emergence from hibernation in spring, because young were born in August and early September in Ohio. Similarly, Atkinson and Netting (1927, pp. 40- 43) speculate that the presence of well-developed embryos in July indicated mating was likely in April of early May. Other observations made (e.g., Guthrie 1927, p. 13) were based on specimens held in captivity and therefore may not mimic the timing of wild breeding snakes. Most recent data indicate that mating is actually most prevalent in summer or early autumn, though it may rarely occur in spring (Table 2.1) (Aldridge and Duvall 2002, p. 6; Aldridge et al. 2008, p. 405; Jellen 2005, p. 41; Johnson 1995, p. 109; Johnson 2000, p. 189; Reinert 1981, pp. 383-384; Swanson 1933, p. 37). Under captive conditions, massasaugas may mate once from March through May, and again in August through September (Johnson 1989, p. 73). The mating system of many pitvipers includes ritualized male-male aggression, sometimes called “combat” to assert dominance, though it is not as well known in the genus Sistrurus (Aldridge and Duvall 2002, p. 20). However, there are published observations of male massasaugas behaving aggressively towards one another (Shepard et al. 2003, pp. 155-156; VanDeWalle 2004, pp. 196-197). These observations took place in tall vegetation (Aldridge et al. 2008, p. 409), which may explain the rarity of similar observations. The behavior has been commonly observed in North American zoos that maintain breeding groups (Johnson 1989, p. 73); although combat rituals do not appear to be necessary to ensure mating success in captives (Andrew Lentini personal communication to M. Redmer October 29, 2014). Males may also use chemical cues to simultaneously trail and pursue individual females during the mating season (Johnson 1989, p. 71). Because mature male EMRs often occur at a higher ratio to receptive females (Table 2.3), competition for mates can be intense. Males may exhibit prolonged periods of mate searching, longer daily movements, and defensive female polygyny during the mating season (Jellen 2005, p. 9; Johnson 2000, p. 189). Like most pitvipers, the EMR is ovoviviparous, meaning embryos develop within eggs held by the female, and gives birth to live young. Data indicate average brood size varies greatly across the range (Table 2.2). While the average brood size was reported as 9.3 (Aldridge et al. 2008, p. 404; Jellen 2005, p. 47), there is also a significant relationship between brood size increasing at higher latitudes (Aldridge 2008, pp. 404-406; Jellen 2005, p. 36). This trend may be explained by longer activity seasons at the southern portion of the range as well as the longer time required to reach the size of sexual maturity at lower latitudes (Aldridge et al. 2008, pp. 404-406). (USFWS, 2016)

Geographic or Habitat Restraints or Barriers

Adult: Busy highway or highway with obstructions such that snakes rarely if ever cross successfully; major river with consistently fast flow; densely urbanized area dominated by buildings and pavement.

Site Fidelity

Adult: High (USFWS, 2016b)

Habitat Narrative

Adult: The eastern massasauga rattlesnake generally occupies shallow wetlands and adjacent upland habitat, though this species has a wide range and shows some variation in the types of habitats it occurs in across this range. Suitable wetland habitat includes peat lands, marshes, sedge meadows, and swamp forest; typical upland habitat includes open savannas, prairies, wet open woodlands, and old fields. A high water table with places to hibernate, such as crayfish burrows or rock crevices, is an important habitat component of this species. Seasonal use of these habitats also varies greatly across the range of the species. More specifically, the habitat varies regionally (Ernst and Ernst 2003). Habitat in the eastern part of the range includes sphagnum bogs, fens, swamps, marshes, peatlands, wet meadows, and floodplains; also open sanannas, prairies, old fields, and dry woodland; the snakes often occur in wetlands in fall, winter, and spring, in drier adjacent uplands in summer. In Ontario, this snake is strongly associated with wetlands and coniferous forest; it avoided open areas (roads, trails), open water, and mixed forest; hibernation sites were in wetlands and coniferous forest (Weatherhead and Prior 1992). At Cicero Swamp in New York, massasaugas used openings in a shrub swamp, hibernated in peatland under a thick blanket of sphagnum moss formed into raised hummocks that overlie often partly water-filled spaces created by a branching network of shrub roots (Johnson 1992, 2000). In Michigan, habitat generally includes a wintering area of low woods, bogs, fens, or marshes, and a summering area of drier ground, usually grassy with low shrubs; hibernation occurs in mammal burrows, crayfish burrows, rock crevices, or tree root systems, or sometimes under partially submerged trash, barn floors, or in basements (Moran, in Johnson and Menzies 1993). In southeastern Michigan, massasaugas selected areas with disproportionate quantities of emergent wetland, scrub/shrub wetland, and lowland hardwood habitats, whereas upland hardwood and all human-altered landscapes were rarely used, even though they were available (Moore and Gillingham 2006). Near Chicago, Illinois, massasaugas tend to be associated with forest edge situations near rivers and shrubby old fields (Mierzwa, in Johnson and Menzies 1993). In Missouri, massasaugas shifted from prairie in spring to upland old fields and deciduous woods in summer, returned to prairie in spring (Seigel 1986).During their active season (after they emerge from hibernacula), they require sparse canopy cover and sunny areas (intermixed with shaded areas) for thermoregulation (basking and retreat sites), abundant prey (foraging sites), and the ability to escape predators (retreat sites). Habitat structure, including early successional stage and low canopy cover, appears to be more important for eastern massasauga rattlesnake habitat than plant community composition or soil type. Individual eastern massasauga rattlesnakes often return to the same hibernacula year after year (USFWS, 2016b).

Dispersal/Migration

Migratory vs Non-migratory vs Seasonal Movements

Adult: Local migrant between winter and summer habitats

Dispersal/Migration Narrative

Adult: This snake has been reported to move seasonally between adjacent wetland and upland habitats. In northwestern Missouri, massasaugas moved seasonally among different habitats (see Johnson and Figg, in Johnson and Menzies 1993). Individuals traveled a few kilometers or more between winter and summer habitats (Johnson and Menzies 1993). In Ontario, activity ranges averaged 0.25 square kilometers (up to 0.76 square kilometers); daily movements were frequent (moved on average of 60 percent of the days) and averaged 56 meters per episode (Weatherhead and Prior 1992). In Pennsylvania, mean home range area was about 1 hectare, and mean home range length was 89 meters (Reinert and Kodrich 1982). Also in Pennsylvania, activity range size of neonates prior to hibernation averaged 0.36 hectares; mean daily distance moved averaged 5.3 meters; neonates returned to their general birthing area to overwinter (Jellen and Kowalski 2007). In New York, estimates of mean activity range (minimum convex polygon) were 2.0 hectares for gravid females (n=2), 27.8 hectares for males (n=11), and 41.4 hectares for nongravid females (n=2) (Johnson 2000). In Michigan, 100 percent minimum convex polygon home ranges averaged 1.3 hectares (range 0.25-4.5 hectares), and daily movement rate averaged 6.9 meters per day (Moore and Gillingham 2006).

Population Information and Trends

Population Trends:

38% decline (USFWS, 2016b)

Resiliency:

As a result of the risk factors acting upon EMR populations, the resiliency of the EMR across its range and within each analysis unit has declined. Rangewide, there are 558 known historical EMR populations of which 263 are known to still be extant, 211 are likely extirpated or known extirpated, and 84 are of unknown status. For the purposes of this assessment, we considered all populations with extant or unknown status as currently extant (referred to as presumed extant, n = 347) (USFWS, 2016b).

Representation:

Low: The degree of representation, as measured by spatial extent, across the EMR range has declined as noted by the northeasterly contraction in the range and by the loss of area occupied within the analysis units. Overall, there has been more than 41% reduction of extent of occurrence (EoO) rangewide. This loss has not been uniform, with losses in the WAU making up most of this decline (70% reduction in EoO in the WAU). However, losses of 33% and 26% in the CAU and EAU, respectively, are notable as well. Assuming that loss of range equates to loss of adaptive diversity, the degree of representation of the EMR has declined since historical conditions (USFWS, 2016b).

Redundancy:

The redundancy of the EMR has also declined since historical conditions. Potential catastrophic events relevant to EMR populations include flooding, disease, and drought. We were unable to find sufficient information on the likelihood of disease outbreaks, the factors that affect disease spread, and the magnitude of impact on EMR populations to assess the risk from a catastrophic disease outbreak. Similarly, we were unable to assess flooding as a catastrophic risk. Thus, we assessed the vulnerability of unit-wide extirpated (AUE) due to varying intensities of drought (USFWS, 2016b).

Number of Populations:

263 (USFWS, 2016b)

Minimum Viable Population Size:

50 adult females (USFWS, 2016b)

Population Narrative:

In the SSA report, a self-sustaining population of eastern massasauga rattlesnakes is defined as one that is demographically, genetically, and physiologically robust (a population with 50 or more adult females and a stable or increasing growth rate), with a high level of persistence (a probability of persistence greater than 0.9) given its habitat conditions and the risk or beneficial factors operating on it. A reasonable conclusion from the composite of genetic studies that exist (Gibbs et al. 1997, entire; Andre 2003, entire; Chiucchi and Gibbs 2010, entire; Ray et al. 2013, entire) is that there are broadscale genetic differences across the range of the eastern massasauga rattlesnake, and within these broad units, there is genetic diversity among populations comprising the broad units. Rangewide, there are 558 known historical eastern massasauga rattlesnake populations, of which 263 are known to still be extant, 211 are likely extirpated or known extirpated, and 84 are of unknown status. The rangewide number of presumed extant populations has declined from the number that was known historically by 38 percent (and 24 percent of the presumed extant populations have unknown statuses) (USFWS, 2016b). Across the species range there has been no significant change in spatial distribution or number of populations since 2016. State summaries are presented below. Indiana: No change in statewide spatial distribution or range (Enbrecht 2021). The population in northeast Indiana is presumed extant. A survey was completed in northeast Indiana in 2015 -2016. This region of the state has the highest occupancy according to historical distribution records. Survey sites were prioritized to be of the greatest value in terms of clarifying presence of the species across the state. Intensive surveys confirmed presence at only two of 15 sites. Occupancy was confirmed at only 14 of 87 historical management units. (Lehman 2017). EMR were observed over the 5 year period and presumed extant in LaPorte, LaGrange, Steuben, Noble and Marshall Counties (IDNR 2020). One new population was identified (Engbrecht 2021). Illinois: No change in statewide spatial distribution or range. The population in Bond and Clinton counties is extant (Lundh 2021, Mangan 2021). Iowa: No change in statewide spatial distribution or range (Lundh 2021). The Muscatine county population is extant. The Scott county population is presumed extant. The Bremer county population is extant. A 2020 survey in Chickasaw County did not find any EMR (VanDeWalle 2020). Missouri: The EMR is extirpated in Missouri. No change (Crabill 2021). Michigan: There was a potential increase in spatial distribution as indicated by nine new element occurrence records (Tansy 2021). Minnesota: The EMR is extirpated in Minnesota. No change (Marsh 2021). New York: No change in statewide spatial distribution or range (Bell 2021, Jundt 2021). Two populations presumed extant (Bell 2021). Ohio: No change in statewide spatial distribution or range. Population in Wyandot County is extant (Boyer 2021). During the 2015 to 2017 period, 12 extant populations were evaluated. Five were stable, 6 unknown or not available, 1 increased and 1 declined (Lipps 2021). Pennsylvania: No change in statewide spatial distribution or range. The population in Butler County is extant and newly restored habitat is being utilized (Kagel 2021). Wisconsin: A population in Jackson County that was presumed extirpated was found to be extant in 2016. A new population was also identified at a site in Jackson County. Another Jackson County population presumed extant in 2016 is no longer considered extant due to lack of suitable habitat. A population in Columbia County that was presumed extirpated was found to be extant in 2016. No overall change in statewide spatial distribution or range (Staffen 2021). (USFWS, 2021a).

Threats and Stressors

Stressor: Development and agricultural practices
Exposure:
Response:
Consequence:
Narrative: Habitat loss is an important factor in the decline of eastern massasauga. The effects of past, widespread wetland loss continue to impact eastern massasauga populations. Development and agriculture practices continue to perpetuate habitat loss, although to a lesser degree than in the past. The majority of extant populations of the eastern massasauga occur on public preserves or other land that is protected (USFWS 1998). However, recent information indicates that

fragmentation and loss of suitable habitat area is continuing even on such sites, and especially where invasive woody vegetation is altering the vegetative structure of massasauga habitat. In general, habitat loss increases the distance between populations and can isolate seasonally used habitats within individual populations. Consequently, eastern massasauga populations become more susceptible to road mortality, predation, and persecution as snakes disperse from populations or make their seasonal movements between habitat types.

Stressor: Nonnative plants (USFWS, 2016b)
Exposure:
Response:
Consequence:
Narrative: Degradation of eastern massasauga rattlesnake habitat typically happens through woody vegetation encroachment or the introduction of nonnative plant species. These events alter the structure of the habitat and make it unsuitable for the eastern massasauga rattlesnake by reducing and eventually eliminating thermoregulatory and retreat areas (USFWS, 2016b).

Stressor: Poaching and collection (USFWS, 2016b)
Exposure:
Response:
Consequence:
Narrative: Because of the fear and negative perception of snakes, many people have a low interest in snakes or their conservation and consequently large numbers of snakes are deliberately killed (Whitaker and Shine 2000, p. 121; Alves et al. 2014, p. 2). Human-snake encounters frequently result in the death of the snake (Whitaker and Shine 2000, pp. 125–126). Given the species' site fidelity and ease of capture once located, the eastern massasauga rattlesnake is particularly susceptible to collection. Poaching and unauthorized collection of the eastern massasauga rattlesnake for the pet trade is a factor contributing to declines in this species (for example, Jellen 2005, p. 11; Baily et al. 2011, p. 171) (USFWS, 2016b).

Stressor: Disease (USFWS, 2016b)
Exposure:
Response:
Consequence:
Narrative: Disease (whether new or currently existing at low levels but increasing in prevalence) is another emerging and potentially catastrophic stressor to eastern massasauga rattlesnake populations. In the eastern and Midwestern United States, the eastern massasauga rattlesnake is specifically vulnerable to disease due to Ophidiomyces fungal infections (snake fungal disease (SFD)). The emergence of SFD has been recently documented in the eastern massasauga rattlesnake (Allender et al. 2011, pp. 2383–2384) and many other reptiles (Cheatwood et al. 2003, pp. 333–334; Clark et al. 2011, p. 890; Pare´ et al. 2003, pp. 12–13; Rajeev et al. 2009, pp. 1265–1267; Sigler et al. 2013, pp. 3343–3344; Sleeman 2013, p. 1), and is concerning because of its broad geographic and taxonomic distributions (USFWS, 2016b).

Stressor: Climate change (USFWS, 2016b)
Exposure:
Response:
Consequence:

Narrative: This species is vulnerable to the effects of climate change through increasing intensity of winter droughts and increasing risk of summer floods, particularly in the southwestern part of its range (Pomara et al., undated; Pomara et al. 2014, pp. 95–97) (USFWS, 2016b).

Stressor: Automobiles (USFWS, 2021a)
Exposure:
Response:
Consequence:
Narrative: Automobiles and predation (by birds of prey, coyotes, feral cats, snakes) account for the largest source of direct mortalities. Auto strikes accounted for the majority (32%). Most mortalities occur in the summer and fall when snakes are most active (Baker 2018). Mortality from vehicle strikes remains the most significant impact of roads (Patterson 2019).

Recovery

Delisting Criteria:
We may initiate an assessment of whether recovery has occurred and delisting is warranted when the following has been accomplished: Criterion 1: 135 robust populations are distributed among the 3 conservation units (Figure 1) as described below. A robust population has more than 50 adult females and a stable or increasing growth rate. Of these 135 robust populations, at least 80 have threats managed to a level where the populations become self-sustaining, by additionally meeting criteria 2 and 3 below. 7 Western Conservation Unit (Southwestern Minnesota, Southern Wisconsin, Eastern Iowa, Eastern Missouri, and Illinois): 11 robust populations. At least 4 of those populations also meet criteria 2 and 3 below. Central Conservation Unit (Michigan's Lower Peninsula, Indiana, and Ohio): 87 robust populations. At least 53 of those populations also meet criteria 2 and 3 below. Eastern Conservation Unit (Western/Central New York, Western Pennsylvania, and Southeastern Ontario): 37 robust population. At least 23 of those populations also meet criteria 2 and 3 below. (USFWS, 2021).

Criterion 2: An adequate quantity and configuration of land is managed and is expected to continue to be managed in a way that will support a robust eastern massasauga rattlesnake population into the future. This criterion will be met when the number of robust populations identified in Criterion 1 occur on lands that have management plans and long-term commitments (extending at least 25 years after delisting) to ensure implementation of those plans. Management plans should identify how the land manager will maintain suitable summer and winter habitats, control threats (including collection and persecution), and monitor the population. Potential funding sources to ensure adequate management should be identified. (USFWS, 2021).

Criterion 3: Threats from climate change and disease are addressed in a way that supports a robust eastern massasauga rattlesnake population into the future. This criterion will be met when the number of robust populations identified in Criterion 1 have management plans that evaluate and address threats from climate change and disease: a. Eastern massasauga rattlesnake populations exist in locations that may be subject to the effects of climate change (for example, catastrophic drought or flooding). Effects of climate change will be better understood through research and modeling. Habitat will be managed to best assist populations to adapt and ensure robust populations persist into the future. Examples include managing altered hydrology and protecting natural hydrological regimes. b. The potential effects of current and emerging disease are understood and sufficiently reduced. (USFWS, 2021).

Recovery Actions:

- Restore wetlands and other habitat to improve and create habitat for massasaugas.
- Control invasive species to improve habitat for massasaugas.
- Conduct strategic roadside mowing to discourage snake use of areas around roads.
- Adjust prescribed burn prescriptions or other land management activities for times when massasaugas are dormant to reduce the likelihood of mortality.
- Increase outreach activities to lessen the public's persecution of massasaugas.
- Encourage private landowners to explore entering Candidate Conservation Agreements (CCA) or Candidate Conservation Agreements with Assurances (CAAA) with the Service so that partner agencies and landowners will work cooperatively with the Service to identify land management measures that would be beneficial to the species.
- The eastern massasauga rattlesnake is State-listed as endangered in Iowa, Illinois, Indiana, New York, Ohio, Pennsylvania, and Wisconsin, and is listed as endangered in Ontario. In Michigan, the species is listed as ‘‘special concern,’’ and a Director of Natural Resources Order (No. DFI– 166.98) prohibits take except by permit (USFWS, 2016b).
- Of the 263 sites with extant eastern massasauga populations rangewide, 62 percent (164) occur on land (public and private) that is considered protected from development; development at the other 38 percent of sites may result in loss or fragmentation of habitat. Signed candidate conservation agreements with assurances (CCAAs) with the Service exist for one population in Ohio, one population in Wisconsin, and populations on State-owned lands in Michigan. These CCAAs include actions to mediate the stressors acting upon the populations and provide management prescriptions to perpetuate eastern massasauga rattlesnakes on these sites. The Wisconsin Department of Natural Resources (DNR) developed a CCAA for one population in Wisconsin. Through the agreement, existing savanna habitat on State land, especially important to gravid (pregnant) females, will be managed to maintain and expand open canopy habitat, restore additional savanna habitat, and enhance connectivity between habitat areas. In Ohio, a CCAA for a State Nature Preserve population addresses threats from habitat loss from the prevalence of late-stage successional vegetation, the threat of fire both pre- and postemergence of eastern massasauga rattlesnakes, and limited connectivity through habitat fragmentation (USFWS, 2016b).
- The State of Michigan developed a CCAA that will provide for management of eastern massasauga rattlesnakes on State-owned lands. This area includes 33 known eastern massasauga occurrences, which represents approximately 34 percent of the known extant occurrences within the State and 10 percent rangewide. In addition, other eastern massasauga rattlesnake sites on county- or municipally owned land, as well as on privately owned land, could be included in the CCAA through Certificates of Inclusion issued by the Michigan Department of Natural Resources (MI DNR) prior to the effective date of listing (see DATES, above). The CCAA includes management strategies with conservation measures designed to benefit the eastern massasauga rattlesnake; these management strategies will be implemented on approximately 136,311 acres (55,263 hectares) of State-owned land. Many of these management actions are ongoing, but we do not have site-specific data on these management actions to include them in our analysis in the SSA. Nonetheless, we determine that the management actions proposed will address some of the threats (for example, habitat loss, vegetative succession) impacting populations on State lands in

Michigan (USFWS, 2016b).

- The Service has information that at an additional 22 sites (that are not covered by a CCAA), habitat restoration or management, or both, is occurring; however, the Service does not have enough information for these sites to know if habitat management has mediated the current stressors acting upon the populations. The Faust model, however, did include these kinds of activities in the projections of trends, and, thus, future condition analyses are based on the assumption that ongoing restoration would continue into the future. Lastly, an additional 18 populations have conservation plans in place. Although these plans are intended to manage for the eastern massasauga rattlesnake, sufficient site-specific information is not available to assess whether these restoration or management activities are currently ameliorating the stressors acting upon the population. Thus, the Service was unable to include the potential beneficial impacts into our quantitative analyses (USFWS, 2016b).
- A. Halt and Reverse Declines 1. Monitor select eastern massasauga rattlesnake populations and assess viability to help guide and evaluate conservation efforts for the eastern massasauga rattlesnake. Regular monitoring of select eastern massasauga rattlesnake populations is important to help provide information on their presence or absence, population size, and other demographic information to help assess population resiliency or persistence. Monitoring a suite of select viable populations where management is occurring can also help determine if population goals are being reached and evaluate the effectiveness of conservation efforts. Efforts to survey or inventory historic sites or immediately adjacent sites can also help identify declining populations, which can then be targeted for management strategies. Recovery implementation strategies developed by individual states and stakeholders can be used to identify the sites where surveys and population monitoring are most needed. Surveys should use established (for example, mark-recapture or other census-based techniques) and/or new (genetics-based) techniques to estimate the effective population size and longterm viability of select eastern massasauga rattlesnake populations, especially when needed to confirm whether populations are robust. We recognize that only a subset of known extant sites can be monitored due to time and funding constraints. Across the range, a select subset of sites that are actively managed for eastern massasauga rattlesnake should be identified (through the Recovery Implementation Strategies) and monitored to inform management elsewhere. We anticipate that this action will take 25 years of implementation. Est. Cost: $850,000 2. Implement habitat management and restoration efforts. Active habitat management is needed to fulfill eastern massasauga rattlesnake habitat requirements in each season and life stage. Furthermore, habitat should be managed in such a way as to allow connectivity among all of the habitat components (basking sites, foraging areas, retreat sites, gestation sites for gravid females, and hibernacula). This action was identified by state and NGO stakeholders as the greatest need for eastern massasauga recovery. This action is already being implemented by most stakeholders as part of routine natural areas management. Greater focus directed to sites with viable populations of this species may be a key in implementing recovery. Ongoing collaboration and cooperation among all stakeholders, including with private landowners, is essential in adopting and implementing land management practices and providing feedback on effectiveness of these practices. We anticipate that this action take 25 years of implementation. Est. Cost: $18,750,000 3. Habitat Protection. Develop a land protection strategy for the eastern massasauga rattlesnake to focus on conserving sufficient quality and quantity of occupied habitat areas and adjacent habitat to provide buffer or to provide additional space for population expansion, with the

goal being to preserve resiliency, representation, and redundancy of the eastern massasauga rattlesnake (Szymanski et al. 2016). This could be done through various mechanisms including short-term conservation programs (for example, USFWS Partners for Fish and Wildlife agreement or U.S. Department of Agriculture Conservation Reserve Program), as well as longer term agreements or land acquisition (for example, fee title, conservation easements – for example, through the North American Wetland Conservation Act or Forest Legacy Programs). This action will likely take ten years of implementation. Est. Cost: $2,500,000 4. Develop and refine recommendations on methods to reduce direct mortality of eastern massasauga rattlesnakes from vehicular strikes, persecution, and collection and incorporate these recommendations into land management plans. The eastern massasauga rattlesnake is reliant on habitat management, but some management actions may increase the risk of mortality (Baker et al. 2016). New approaches and best management practices need to be developed to help managers implement needed actions while minimizing regulatory burdens. This action will likely take ten years of implementation. Est. Cost: $2,250,000 5. Develop and implement conservation strategies that help remediate the effects of climate variability and subsequent hydrological fluctuations in eastern massasauga rattlesnake habitat. A climate change vulnerability assessment (CCVA) indicated that extreme fluctuations in the water table are demographic stressors for the eastern massasauga rattlesnake (Pomara et al. 2014). Eastern massasauga rattlesnake conservation should include strategies to minimize the effects of hydrological fluctuations during drought and flooding events, such as management or conservation of natural vegetative cover and hydrology within occupied eastern massasauga rattlesnake habitat (Pomara et al. 2014, p. 2,097). Remediation strategies for climatic stressors in the western, central, and southeastern portions of the range should be developed, since these areas were shown to have high extinction probabilities in the CCVA (Pomara et al. 2014, p. 2,097). This action will likely take ten years of implementation. Est. Cost: $1,500,000 (USFWS, 2021).

- B. Ensure that the breadth of adaptive diversity is maintained. 1. Identify key populations to prioritize for protection within each conservation unit in order to maintain adaptive diversity. Use genetic, geographic, and ecological data to identify populations that are robust and represent the range of adaptive capacity for this species. We anticipate that this action will take three years of implementation after States adopt their individual Recovery Implementation Strategies. Est. Cost: $80,000 2. Survey for previously unknown eastern massasauga rattlesnake populations in areas that are important to preserving adaptive capacity and meeting recovery criteria and where the status of populations is unknown. It is important to survey in an effort to find previously undiscovered eastern massasauga rattlesnake populations. These newly identified populations can be monitored for population demographics and targeted for conservation efforts, particularly if they are genetically distinct or adapted to a specific set of environmental conditions. Such populations may prove to be important to the species' adaptive capacity and the preservation of its representation across the range. Survey efforts in areas where populations previously occurred, but have since become unknown, can also be useful for eastern massasauga rattlesnake recovery efforts. In some cases, populations have gone without monitoring for an extended period. In others, the eastern massasauga rattlesnake has simply gone undetected in spite of survey efforts. The eastern massasauga rattlesnake's secretive behavior and cryptic coloration make it a difficult species to detect, especially when populations are small or dispersed in low densities over large areas. The absence of eastern massasauga rattlesnake detection at a site where this species has previously been recorded does not necessarily prove it has been extirpated. Long-term survey efforts should be conducted before extirpation is assumed, particularly if such populations are believed to be important to the preservation of this species' adaptive capacity. We anticipate that this action will take five years of implementation. Est. Cost: $200,000 (USFWS, 2021).

- C. Increase public tolerance and support for eastern massasauga rattlesnake conservation. 1. Engage and provide cooperative support for landowning organizations and private landowners when they can assist in eastern massasauga rattlesnake conservation. We anticipate that this action will take 25 years of implementation. Est. Cost: $400,000 2. Incentivize actions that benefit the eastern massasauga rattlesnake and its habitat, while also recognizing the needs of landowners. Some landowners may wish to continue using land in ways that are compatible with eastern massasauga rattlesnake management (such as upland bird hunting), but do not have the resources to improve habitat in a way that benefits both targets. We anticipate that this action will take ten years of implementation. Est. Cost: $200,000 3. Work with local outreach partners to increase outreach that highlights the role and benefits to the ecosystem when eastern massasauga rattlesnakes are present. We anticipate that this action will take ten years of implementation. Est. Cost: $300,000 (USFWS, 2021).
- D. Increase our knowledge and understanding to ensure effective recovery of the eastern massasauga rattlesnake. 1. Evaluate the effects of habitat management activities, including species and habitat responses to management treatments (to support effective habitat management and restoration efforts (action A.2)). Additional research, monitoring, and analysis are needed to determine appropriate management options for maintaining, enhancing, and restoring eastern massasauga rattlesnake habitat in an adaptive management approach. Research on best management practices should be re-examined and refined with the goal of effectively reducing mortality to the eastern massasauga rattlesnake, while also achieving habitat management objectives. We anticipate that this action will take 25 years of implementation. Est. Cost: $100,000 2. Investigate the risks of disease to populations of the eastern massasauga rattlesnake and potential management options. Epidemiological surveys and research are needed to determine the extent of snake fungal disease and other disease-causing pathogens that could potentially be a stressor to populations of the eastern massasauga rattlesnake. Research should be conducted to determine the factors that influence the prevalence of snake fungal disease among eastern massasauga rattlesnake populations (Allender et al. 2016), and populations should be assessed for their potential vulnerability to the risk of a disease outbreak. Strategies to minimize the impacts of disease at the population and species level as well as to enhance the health of individual eastern massasauga rattlesnakes should be developed. This action would likely take ten years of implementation. Est. Cost: $1,500,000 3. Address effects of climate change through research, reconnaissance, and adaptive management. This action will also support developing and implementing conservation strategies that help remediate the effects of climate variability and subsequent hydrological fluctuations in eastern massasauga rattlesnake habitat (action A.5). Climate change has been projected to impact eastern massasauga rattlesnake populations through increased catastrophic flooding, localized droughts, and increasing invasion by woody species. Identifying key/specific sites (adjacent to water-control reservoirs where flooding is likely) that are at high risk from climate-driven factors affecting key populations needed for recovery, and finding ways to remediate for impacts could be crucial for maintaining adaptive capacity, especially near the edges of the range of the eastern massasauga rattlesnake. Identify new management approaches for established invasive species and identify new invaders that may be a

potential threat to the preferred habitat of the eastern massasauga rattlesnake. We anticipate that this action will take 25 years of implementation. Est. Costs: $1,500,000 4. Explore the need, cost/benefits, and feasibility of eastern massasauga rattlesnake population restoration efforts through captive propagation and augmentation. Populations that are believed to be at high risk for extirpation may benefit from targeted captive propagation or attempts at population augmentation, especially if, and after, the threats to those populations are addressed. While this may increase resiliency of some populations, and adaptive capacity of the species, attempts to augment or introduce the eastern massasauga rattlesnake to the wild should be considered investigational and the USFWS should consider use of experimental populations per section 10(j) of the ESA, where appropriate. This action would likely take ten years of implementation. Est. Costs: $750,000 5. Collaboratively use genetic data for assessing population viability and guiding captive management, if captive management is deemed needed for recovery (see Action D4). Recent advances in population genetics techniques allow adaptive variation, demography, and effective population size to be estimated without long-term monitoring in the field. The eastern massasauga rattlesnake has been the subject of several range-wide and population level genetics studies. These existing studies and additional genetics research should guide management of captive populations, should they be deemed necessary for recovery, to ensure appropriate diversity is available for potential future reintroductions. Collaboration among the USFWS, stakeholders, and researchers will be crucial to standardize data reporting and analysis. We anticipate that this action will take five years of implementation. Est. Cost: $250,000 6. Achieve a better understanding of genetic diversity in the eastern massasauga rattlesnake. The eastern massasauga rattlesnake is a wide-ranging species that can have detectable genetic structure between neighboring populations in small portions of its range. Adaptive significance of this is not fully understood and may help inform recovery implementation (for example, action B.1). This action would likely take five years to investigate priority questions. Est. Costs: $250,000 (USFWS, 2021).

Conservation Measures and Best Management Practices:

- New Recovery Priority Number: A Recovery Priority Number (RPN) was not assigned to the species prior to this 5-year review. We recommend a RPN of 8 on a scale of 1 (highest) to 18 (lowest). A RPN of 8 indicates this species faces a moderate degree of threat and has a high recovery potential. The moderate degree of threat recognizes that threats are numerous, and ongoing, yet are reasonably well understood and can be managed. The decline of the eastern massasauga is primarily the result of habitat loss and fragmentation (Szymanski et al. 2016, Executive Summary, p. v). These stressors have had negative impacts on eastern massasauga populations and their habitat for decades. The recovery potential of the species is high due to the ability to reduce impacts through habitat conservation and expansion. RECOMMENDATIONS FOR FUTURE ACTIONS: Continue to work with our partners to complete the recovery implementation strategies and work to implement the highest priority activities. (USFWS, 2021a)
- Study findings suggest that EMR may benefit from management plans that encourage reductions in average canopy cover while maintaining adequate refugia from predators and harsh conditions (Thacker 2020). (USFWS, 2021a)

References

USFWS 2013. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for Sistrurus catenatus (Eastern Massasauga). 04/29/2013. Region 3, Great Lakes-Big Rivers Region.

19 p.

USFWS. 2016a. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/ecp0/. Accessed September 2016. USFWS. 2021a. 5-YEAR REVIEW Eastern Massasauga Rattlesnake (Sistrurus catenatus). 13 pp.

USFWS 2016. 80 FR 67193 67214. Endangered and Threatened Wildlife and Plants

Threatened Species Status for the Eastern Massasauga Rattlesnake. Fish and Wildlife Service, Interior.

USFWS. 2016b. Endangered and Threatened Wildlife and Plants

Threatened Species Status for the Eastern Massasauga Rattlesnake

Final rule. 81 Federal Register 190. September 30, 2016. Pages 67193 - 67214.

Final rule. 81 Federal Register 190. September 30, 2016. Pages 67193 - 67214. USFWS. 2021a. 5-YEAR REVIEW Eastern Massasauga Rattlesnake (Sistrurus catenatus). 13 pp.

USFWS. 2013. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for Sistrurus catenatus (Eastern Massasauga). 04/29/2013. Region 3, Great Lakes-Big Rivers Region. 19 p.

USFWS. 2021a. 5-YEAR REVIEW Eastern Massasauga Rattlesnake (Sistrurus catenatus). 13 pp.

USFWS. 2021. Recovery Plan for the Eastern Massasauga Rattlesnake (Sistrurus catenatus). USFWS Great Lakes Region (Region 3), Bloomington, Minnesota. 15pp.

SPECIES ACCOUNT: *Sternotherus depressus* (Flattened musk turtle)

Species Taxonomic and Listing Information

Commonly-used Acronym: FMT

Listing Status: Threatened; 06/11/1987; Southeast Region (R4)

Physical Description

The flattened musk turtle is a small aquatic turtle having a distinctly flattened carapace up to 12 centimeters or 4.7 inches long, with keels virtually, if not altogether, lacking (Mount 1981). The carapace varies from very dark brown to orange with dark bordered seams and is slightly serrated behind (Ernst and Barbour 1972). The plastron is pink to yellowish. The head is greenish with a dark reticulum that often breaks up to form spots on the top of the snout (Mount 198]). Stripes on the top and sides of the neck, if present, are narrow. There are two barbels on the chin, all four feet are webbed, and males have thick, long, spine-tipped tails (Ernst and Barbour 1972) (USFWS, 1990).

Taxonomy

The genus Sternotherus was merged into the genus Kinosternon by Ernst and Barbour (1989) (based on protein electromorph data of Seidel et al. 1986). This change not adopted in subsequent taxonomic lists (King and Burke 1989, Collins 1990). However, Iverson (1991) evaluated protein and morphological data for kinosternine turtles and concluded that there presently exists no adequate basis for recognizing Sternotherus as a genus distinct from Kinosternon. Nevertheless, Ernst et al. (1994) treated Kinosternon and Sternotherus as distinct genera (NatureServe, 2015).

Historical Range

See current range/distribution.

Current Range

Historically restricted to upper Black Warrior River system, northern Alabama, upstream from Fall Line; largest known population is in Sipsey Fork in north-central Alabama (NatureServe, 2015).

Distinct Population Segments Defined

No

Critical Habitat Designated

No;

Life History

Feeding Narrative

Adult: Flattened musk turtles feed primarily on mollusks (Marion, et al. 1986) (USFWS, 1990).

Reproduction Narrative

Adult: This turtle does not mature sexually until 4-8 years of age, and normally deposits only 1 to 2 clutches of eggs per year with 1 to 3 eggs per clutch (Close 1982) (USFWS, 1990).

Environmental Specificity

Adult: Narrow/Specialist (inferred from USFWS, 1990)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1990)

Site Fidelity

Adult: High (inferred from USFWS, 1990)

Habitat Narrative

Adult: The flattened musk turtle is found in a variety of streams and in the headwaters and around the margins of some impounded lakes. However, its optimum habitat appears to be free-flowing large creeks or small rivers having vegetated shallows from a few centimeters to about 0.6 meters (2 feet) deep, alternating with pools 1.1 to 1.5 meters (3.6 to 5 feet) deep. These pools have a detectable current and an abundance of crevices and submerged rocks, overlapping flat rocks, or accumulations of boulders. Other factors contributing to habitat quality for this turtle include abundant molluscan fauna, low silt load and deposits, low nutrient content and bacterial count, moderate temperature, and minimal pollution (Estridge 1970, Mount 1981). Ernst, et al. (1983) reported that S. depressus also inhabits stream stretches with sandy bottoms, alternating with suitable cover sites (USFWS, 1990). Environmental specificity, Ecological integrity, tolerance ranges and site fidelity are inferred based on habitat needs and Site fidelity are based on habitat needs.

Dispersal/Migration

Motility/Mobility

Adult: Low (inferred from USFWS, 2014)

Migratory vs Non-migratory vs Seasonal Movements

Adult: Non-migratory (inferred from USFWS, 1990)

Dispersal

Adult: Low (inferred from USFWS, 1990)

Immigration/Emigration

Adult: Unlikely (inferred from USFWS, 1990)

Dispersal/Migration Narrative

Adult: Low mobility is inferred based on the species inability to swim well (USFWS, 2014). Non-migratory, low dispersal and unlikely immigration/emigration are based on specific habitat requirements and low numbers of populations (inferred from USFWS, 1990)

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Population Growth Rate:
Low (inferred from USFWS, 1990 and NatureServe, 2015)

Number of Populations:
1 to 5 (NatureServe, 2015)

Resistance to Disease:
Low (inferred from USFWS, 1990 and NatureServe, 2015)

Population Narrative:
NatureServe (2015) notes that the short-term population trend is a decrease of 10 to 30%. Low resiliency is based on low number of populations and number of heathy populations (NatureServe, 2015). Representation and redundancy are inferred based on a low number of populations. Low resistance to disease is based on a number of turtles parasitized by turtle malaria protozoa and septicemia noted in the threats comments (USFWS, 1990).

Threats and Stressors

Stressor: Habitat Alteration (USFWS, 1990)
Exposure:
Response:
Consequence:
Narrative: Dodd, et al. (1988) concluded, after an intensive study, that siltation appears to have seriously impacted the flattened musk turtle. Possible adverse effects of silt include: (1) extirpation or reduction in populations of mollusks and other invertebrates on which the turtles feed; (2) physical alteration of the rocky habitats where the turtles seek food and cover; and (3) development of a substrate in which chemicals toxic to the turtles or their food sources may accumulate and persist. Activities and sources that have historically contributed to the siltation problem include agriculture, forestry, mining, and industrial and residential development. Recent passage of laws provide the means to regulate the amounts of silt that these activities can contribute to streams. Even if such regulation proves effective in stopping future flattened musk turtle habitat degradation, stream recovery is a slow process. That and the turtle's low reproductive rate will insure that meaningful improvement in its population status will require a long time. Pollution by organic and inorganic chemicals degrades water quality in the flattened musk turtle habitat and may affect its survival. Shell erosion and loss of invertebrate food organisms are possible adverse effects of such pollution (Mount 1981). Finally, hydrologic changes associated with mining (including declines in water level, creation of spoil aquifers, and changes in streamflow characteristics); and various navigation and flood control projects may have adverse effects on the habitat of the flattened musk turtle. These activities cause range fragmentation which, according to Dodd et al. (1988), is a serious problem to the flattened musk turtle (USFWS, 1990)

Stressor: Overutilization (USFWS, 1990)
Exposure:
Response:
Consequence:

Narrative: The flattened musk turtle has been listed for sale on several dealer price lists at more than $80 each. Most of the formerly good populations have been considerably reduced through commercial collecting in recent years. “Collecting that permanently removes individuals from a population represents additional ‘mortality’ to the population which must be offset with higher than normal recruitment in order to maintain stable populations; however, recruitment appears low in flattened musk turtles” (Congdon, et al. 1987). A State law prohibiting the taking of flattened musk turtles was passed on May 21, 1984. This law and the Endangered Species Act provide a mechanism to control collecting (USFWS, 1990).

Stressor: Disease and parasites (USFWS, 1990)
Exposure:
Response:
Consequence:
Narrative: Estridge (1970) found three of seven specimens parasitized by a protozoan agent of turtle malaria. Ernst, et al. (1983) found some specimens heavily parasitized by a leech that carries the protozoan. A disease characterized by a mixed gram-negative septicemia has been noted in populations of the flattened musk turtle (Dodd 1988). Almost one-fourth of the turtles caught by Dodd, et al. (1988) in the last trap sample at one site were diseased; and more than one-half of all turtles of this species observed basking in the Dodd study were considered sick (USFWS, 1990).

Stressor: Altered pattern of Genetic Exchange (USFWS, 1990)
Exposure:
Response:
Consequence:
Narrative: Historically, the flattened musk turtle was found in the upper Black Warrior River system of Alabama upstream from the fall line, the break between interior provinces and the coastal plain (Tinkle 1959; Estridge 1970; Mount 1976, 1981; Ernst, et al. 1983). Beginning about 1930, several dams were built on the Black Warrior River below and near the fall line. The impoundments created behind those dams extend from well below to well above the steep gradient in streams as they cross the fall line. It has been hypothesized that creation of the impoundments allowed the range of S. m. peltifer (previously limited to below the fall line) to be functionally connected for the first time to the river above the fall line, and to have contact with the range of S. depressus (Iverson 1977a,b; Seidel and Lucchino 1981). This linkage eliminated a natural, environmental barrier to interbreeding between S. depressus and S. m. peltifer Iverson 1977a,b). Bankhead Dam, which was constructed in 1915 and prior to the impoundments near the fall line, is further upstream and now constitutes the primary physical barrier between the ranges of S. depressus and S. m. peltifer. As a result of these habitat modifications, the Black Warrior River system below Bankhead Dam but above the fall line may now contain hybrid populations of Sternotherus turtles (Iverson 1977a,b; Mount 1981). Another interpretation is that the area from the fall line to where Bankhead Dam is now located was an area of natural intergradation between distinct taxon (Mount 1981). If hybridization or an altered pattern of natural intergradation is occurring due to habitat modification, the process may threaten the flattened musk turtle as a taxon if that modification continues (USFWS, 1990).

Stressor: Biological characteristics (USFWS, 1990)
Exposure:
Response:

Consequence:
Narrative: Several biological characteristics of the flattened musk turtle increase its vulnerability to the threats discussed previously. This turtle does not mature sexually until 4-8 years of age, and normally deposits only 1 to 2 clutches of eggs per year with 1 to 3 eggs per clutch (Close 1982). This low reproductive rate reduces the ability of the species to recover rapidly from anything that decimates the population or to respond rapidly to recovery activities. Since the flattened musk turtle occurs only in the upper Black Warrior River basin, it evidently has rather specific habitat requirements. This factor increases the likelihood of adverse impact from habitat modifications. Flattened musk turtles feed primarily on mollusks (Marion, et al. 1986), which are particularly susceptible to water pollution. The turtles also feed and spend virtually all of their time at the stream bottom and thus are in almost constant contact with any toxic sediments that may be present (USFWS, 1990)

Recovery

Delisting Criteria:
Improve habitat quality (USFWS, 1990)

Assess threats to turtle population and monitor its status (USFWS, 1990)

Reduce isolation of individual populations (USFWS, 1990)

Decrease incidence of disease, if significant (USFWS, 1990)

Reduce adverse genetic exchange above Bankhead Dam (USFWS, 1990)

Recovery Actions:
- Develop a habitat restoration plan and implement actions to restore habitat (USFWS, 1990).
- Develop a study plan, conduct studies and reduce on-going adverse actions (USFWS, 1990).
- Corrective action should emphasize restoring altered habitat areas to reestablish natural corridors. Isolated populations would then have the opportunity for reproductive contact again (USFWS, 1990).
- If study results indicate that the magnitude of disease is significant, efforts should be made to identify the causative agent and to take corrective action (USFWS, 1990).
- Hybridization of S. depressus with S. m. peltifer may have occurred below Bankhead Dam due to the construction of impoundments above and below the fall line, a former natural barrier. Altering this barrier with impoundments created a situation that may have allowed the two taxon to interbreed. If study results indicate the current pattern of genetic exchange poses a threat to the listed population of the flattened musk turtle, the causative factor should be determined and corrective action taken (USFWS, 1990).
- Revise recovery plan. The use of Guthrie (1986) in the recovery plan should be clarified or replaced with improved statistical means of determining habitat quality related to FMT population viability (USFWS, 2014).
- Continue implementing pertinent recovery actions from the FMT Recovery Plan (U.S. Fish and Wildlife Service 1990) (USFWS, 2014).
- Reengage FMT Recovery Group (USFWS, 2014).

- Define the species' current range by a range wide status survey of historically known range and any other possible stream reaches that have not been sampled (USFWS, 2014).
- Develop range wide population and habitat monitoring plan (USFWS, 2014).
- Establish collection metrics for PVA and minimum and maximum sustainable yield of the populations (USFWS, 2014).
- Determine and maintain instream flows within the habitat of the species (USFWS, 2014).
- Support the State of Alabama comprehensive conservation strategy efforts concerning the FMT (Alabama Department of Conservation and Natural Resources 2005) (USFWS, 2014).
- Support the Alabama Water Watch, Black Warrior River Keeper, Partners in amphibian and reptile conservation (Bailey et al. 2010) and other conservation efforts within the Black Warrior River Basin (Alabama River Alliance 2003; Alabama Water Watch 2002) (USFWS, 2014).
- Support actions for stream and riparian management for freshwater turtles as described by Bodie (2001) and Bailey et al (2006) (USFWS, 2014).
- Continue partnering with stakeholders (e.g. Forest Service, landowners, nongovernmental organizations) in protecting FMT habitat (USFWS, 2014).
- Restore degraded habitat especially with regard to storm water runoff and other nonpoint source pollution (USFWS, 2014).
- Develop protection and management plans for all watersheds sites as indicated by information acquired from habitat and population survey studies (USFWS, 2014).
- Develop and initiate captive head start and husbandry program at Atlanta/Birmingham Zoos or equivalent facility (Hill 2011, pers. comm. to Drennen) (USFWS, 2014).
- Support conservation, outreach and management practices with the Lewis Smith Lake Reservoir Homeowners association and watershed management group (USFWS, 2014).

References

U.S. Fish and Wildlife Service. 1990. Flattened Musk Turtle Recovery Plan. Jackson, Mississippi. 15 pp

NatureServe Explorer (2015): An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://explorer.natureserve.org. (Accessed: March 18, 2016)

U.S. Fish and Wildlife Service. 2014. Flattened Musk Turtle (Sternotherus depressus) 5-Year Review: Summary and Evaluation U.S. Fish and WIldlife Service Southeast Region Mississippi Ecological Services Field Office Jackson Mississippi.

USFWS. 2014. Flattened Musk Turtle (Sternotherus depressus). 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Southeast Region, Mississippi Ecological Services Field Office, Jackson, Mississippi. 30 pp.

SPECIES ACCOUNT: *Thamnophis eques megalops* (Northern Mexican gartersnake)

Species Taxonomic and Listing Information

Listing Status: Threatened; July 8, 2014; Southwest Region (R2)

Physical Description

The northern Mexican gartersnake may occur with other native gartersnake species and can be difficult for people without herpetological expertise to identify. With a maximum known length of 44 inches (in) (112 centimeters (cm)), it ranges in background color from olive to olive-brown to olive-gray with three stripes that run the length of the body. The middle dorsal stripe is yellow and darkens toward the tail. The pale yellow to light-tan lateral stripes distinguish the Mexican gartersnake from other sympatric (co-occurring) gartersnake species because a portion of the lateral stripe is found on the fourth scale row, while it is confined to lower scale rows for other species.

Taxonomy

Prior to 2003, Thamnophis eques was considered to have three subspecies, T. e. eques, T. e. megalops, and T. e. virgatenuis (Rossman et al. 1996, p. 175). In 2003, an additional seven new subspecies were identified under T. eques: (1) T. e. cuitzeoensis; (2) T. e. patzcuaroensis; (3) T. e. insperatus; (4) T. e. obscurus; (5) T. e. diluvialis; (6) T. e. carmenensis; and (7) T. e. scotti (Conant 2003, p. 3).

Historical Range

Within the United States, the northern Mexican gartersnake historically occurred predominantly in Arizona at elevations ranging from 130 to 6,150 ft (40 to 1,875 m). It was generally found where water was relatively permanent and supported suitable habitat. The northern Mexican gartersnake historically occurred in every county and nearly every subbasin within Arizona, from several perennial or intermittent creeks, streams, and rivers as well as lentic (still, non-flowing water) wetlands such as cienegas, ponds, or stock tanks. Historically, the northern Mexican gartersnake had a limited distribution in New Mexico that consisted of scattered locations throughout the Upper Gila River watershed in Grant and western Hidalgo Counties, including the Upper Gila River, Mule Creek in the San Francisco River subbasin, and the Mimbres River (Price 1980, p. 39; Fitzgerald 1986, Table 2; Degenhardt et al. 1996, p. 317; Holycross et al. 2006, pp. 1–2). One record for the northern Mexican gartersnake exists for the State of Nevada, opposite Fort Mohave, in Clark County along the shore of the Colorado River that was dated 1911 (De Queiroz and Smith 1996, p. 155). The subspecies may have occurred historically in the lower Colorado River region of California, although we were unable to verify any museum records for California. Any populations of northern Mexican gartersnakes that may have historically occurred in either Nevada or California were likely associated directly with the Colorado River, and we believe them to be currently extirpated.

Current Range

U.S.: Apache, Cochise, Coconino, Gila, Graham, Greenlee, La Paz, Mohave, Navajo, Pima, Pinal, Santa Cruz, and Yavapai counties, AZ; Catron, Grant, and Hidalgo counties, NM; Mexico: Chihauhua, Durango, Guanajuato, Hidalgo, San Luis Potosi, and Sonora states. Fagan (2004, pp.

233–243). Based on museum records found in Holycross et al. (2006, Appendix F), we expect the northern Mexican gartersnake retained its entire historic distribution within the United States through the 1920s and likely into the 1930s. Currently, in southeastern Arizona, populations occur at the San Bernardino National Wildlife Refuge, Finley Tank (Audubon Society's Appleton-Whittell Research Ranch), Scotia Canyon (Huachuca Mountains), San Raphael Valley, Canelo Hills, Sonoita Grasslands, Babocomari, Ciénega Creek, Arivaca Cienega, sites on the San Pedro River, and Huachuca Mountain bajada. However, most of these populations are experiencing declines or are characterized by low density (Rosen et al. 2001). Camp Verde and Sonoita Grassland-Canelo Hills-San Raphael Valley are the only areas with substantial populations (Rosen et al. 2001). In New Mexico, this snake is currently known from the lower Gila River basin, along Duck and Mule creeks in Grant County and near Virden in Hildago County (Hubbard and Eley 1985, cited by New Mexico Department of Game and Fish 1997). It may now be eliminated from Duck Creek (New Mexico Department of Game and Fish 1997). A record from a single locality along Mule Creek is the only recent evidence of the presence of this species in New Mexico, but the current status of that population is unknown (Center for Biological Diversity 2003).

Distinct Population Segments Defined

No

Critical Habitat Designated

Yes; 5/8/2021.

Legal Description

We, the U.S. Fish and Wildlife Service (Service), designate critical habitat for the northern Mexican gartersnake (Thamnophis eques megalops) under the Endangered Species Act of 1973 (Act), as amended. In total, approximately 20,326 acres (8,226 hectares) in La Paz, Mohave, Yavapai, Gila, Cochise, Santa Cruz, and Pima Counties, Arizona, and Grant County, New Mexico, fall within the boundaries of the critical habitat designation for the northern Mexican gartersnake. This rule extends the Act’s protections to the northern Mexican gartersnake’s designated critical habitat. DATES: This rule is effective May 28, 2021. (USFWS, 2021)

Critical Habitat Designation

We are designating eight units as critical habitat for the northern Mexican gartersnake. The critical habitat areas we describe below constitute our current best assessment of areas that meet the definition of critical habitat for the northern Mexican gartersnake. The eight areas we designate as critical habitat for the northern Mexican gartersnake are: (1) Upper Gila River Subbasin; (2) Tonto Creek; (3) Verde River Subbasin; (4) Bill Williams River Subbasin; (5) Arivaca Cienega; (6) Cienega Creek Subbasin; (7) Upper Santa Cruz River Subbasin; and (8) Upper San Pedro River Subbasin. Table 1 shows the critical habitat units and the approximate area of each unit. We present brief descriptions of all units, and reasons why they meet the definition of critical habitat for the northern Mexican gartersnake, below. Unit 1: Upper Gila River Subbasin Unit Unit 1 consists of 1,133 ac (458 ha) along 13 stream mi (21 km) in two subunits, with 9 stream mi (14 km) along the Gila River and 4 stream mi (6 km) along Duck Creek. The Upper Gila River Subbasin Unit is located in southwestern New Mexico southeast of the towns of Cliff and Gila, in Grant County. The New Mexico Department of Game and Fish, New Mexico State Land Department, and private entities manage lands within this unit. Unit 1 is designated as critical habitat because it was occupied at the time of listing and as a whole, this unit contains PBFs 1, 2, and 5, but PBFs 3 and 4 are in degraded condition. PBFs 6 and 7 do not apply to this unit. Northern Mexican gartersnakes have been found in the Gila River near the Highway 180 crossing in 2002, 2013, and 2015, and just outside of Duck Creek near it's confluence with the Gila River in 2018 (Hill 2007, pers. comm.; Hotle 2013, p.1; Geluso 2016, pers. comm.; Geluso 2018, pers. comm.; and Holycross et al. 2020, p. 717). Several reaches of the Gila River have been adversely affected by channelization and diversions, which have reduced or eliminated base flow. The PBFs in this unit may require special management due to competition with, and predation by, nonnative species that are present in this unit; water diversions; channelization; potential for high-intensity wildfires; and human development of areas adjacent to critical habitat. Unit 2: Tonto Creek Unit Unit 2 consists of 3,176 ac (1,285 ha) of critical habitat along 29 stream mi (47 km) of Tonto Creek. The Tonto Creek Unit is generally located near the towns of Gisela and Punkin Center, Arizona, in Gila County. The downstream end of critical habitat is the Conservation Storage elevation of Theodore Roosevelt Lake (2,151 ft (656 m)) near the confluence with Ash Creek. The Tonto National Forest is the primary land manager in this unit, with additional lands privately owned. Unit 2 is designated as critical habitat because it was occupied at the time of listing and as a whole, this unit contains PBFs 1, 2, 3, and 5, but PBF 4 is in degraded condition. PBFs 6 and 7 do not apply to this unit. Northern Mexican gartersnakes have been found in Tonto Creek in 2004, 2005, and 2010 to 2017 in the vicinity of Gisela, Arizona (Holycross et al. 2006, p. 42; Burger 2010, p. 1; Madara-Yagla 2010, p. 6; Madara-Yagla 2011, p. 6; Madara-Yagla 2012, pers. comm.; Nowak et al. 2015, Table 1; Nowak 2015, p. 2; Nowak et al. 2016, Table 1; Myrand et al. 2016, pp. 5–6; Myrand et al. 2017; Nowak 2017, p. 6; and Holycross et al. 2020, p. 717). Some reaches along Tonto Creek experience seasonal drying because of regional groundwater pumping, while others are affected by diversions. Development along private reaches of Tonto Creek may also affect terrestrial characteristics of northern Mexican gartersnake habitat. Mercury has been detected in fish samples within Tonto Creek, and further research is necessary to determine if mercury is bioaccumulating in the resident food chain. Theodore Roosevelt Lake is a nonnative sport fishery and supports predators of the northern Mexican gartersnake, so that the northern Mexican gartersnake may be subject to higher mortality from predation by nonnative fish at the downstream end of this unit, especially when these species are more likely to be present when the lake level is at Conservation Storage elevation. The PBFs in this unit may require special management due to competition with, and predation by, nonnative species that are present in this unit; water diversions causing loss of base flow; flood-control projects; and development of areas adjacent to or within critical habitat. Unit 3: Verde River Subbasin Unit Unit 3 consists of 5,265 ac (2,131 ha) along 64 stream mi (102 km) in three subunits: 39 stream mi (62 km) of the Verde River, including Tavasci Marsh and Peck Lake; 22 stream mi (35 km) of Oak Creek; and 4 stream mi (6 km) of Spring Creek. The Verde River Subbasin Unit is generally located near the towns of Cottonwood, Cornville, and Camp Verde, Arizona, in Yavapai County. The Verde River Subbasin Unit occurs on lands managed by the U.S. Forest Service on Coconino and Prescott National Forests; National Park Service (NPS) at Tuzigoot National Monument; Arizona State Parks at Deadhorse Ranch and Verde River Greenway State Natural Area; Arizona State Trust; and private entities. Unit 3 is designated as critical habitat because it was occupied at the time of listing and as a whole, this unit contains PBFs 1, 2, 3, and 5, but PBF 4 is in degraded condition. Northern Mexican gartersnakes have been found in the Verde River at Tuzigoot National Monument, Tavasci Marsh, Dead Horse Ranch State Park, Camp Verde Riparian Preserve, and upstream of Beasley Flat from 2003 to 2019; in and adjacent to Oak Creek at the Bubbling Ponds and Page Springs hatcheries from 2007 to 2018; and in Spring Creek downstream of Highway 89A in 2014 (Schmidt et al. 2005, Table 5.9; Holycross et al. 2006, Appendix A; Boyarski 2011, entire; Nowak et al. 2011, Table 1; Nowak

2012, pers. comm.; I. Emmons 2012, pers. comm.; Emmons and Nowak 2013, Table 1; Crowder 2014, pers. comm.; Nowak 2015, p.1; Emmons and Nowaks 2016, Appendix 1; Nowak 2017, pers. comm.; Greenawalt 2018, pers. comm.; Ryan 2018, pers. comm.; Ryan 2019, pers. comm.; Jenney 2019, pers. comm.; and Holycross et al. 2020, p. 717). Crayfish, bullfrogs, and nonnative, spiny-rayed fish are present in some of this unit. Proposed groundwater pumping of the Big Chino Aquifer may adversely affect future base flow in the Verde River. Development along the Verde River has eliminated habitat along portions of the Verde River through the Verde Valley. The PBFs in this unit may require special management due to competition with, and predation by, nonnative species that are present in this unit; water diversions; existing and proposed groundwater pumping potentially resulting in drying of habitat; potential for high-intensity wildfires; and human development of areas adjacent to critical habitat. We have excluded 225 ac (91 ha) of lands owned by the Yavapai-Apache Nation, and 142 ac (57 ha) of AGFD’s Bubbling Ponds and Page Springs fish hatcheries in Oak Creek Subunit (see Exclusions, below). Unit 4: Bill Williams River Subbasin Unit Unit 4 consists of 2,245 ac (908 ha) along 13 stream mi (22 km) in two subunits: 8 stream mi (13 km) of Big Sandy River and 5 stream mi (9 km) of Santa Maria River. The Bill Williams River Subbbasin Unit is generally located in western Arizona, northeast of Parker, Arizona, in La Paz and Mohave Counties. The Bill Williams River Subbasin Unit occurs on lands managed by the Bureau of Land Management (BLM) within the Rawhide Mountains Wilderness, Swansea Wilderness, and Three Rivers Riparian Area of Critical Environmental Concern (ACEC); Arizona State Parks at Alamo Lake State Park; Arizona State Land Department; and private landowners. Unit 4 is designated as critical habitat because it was occupied at the time of listing and as a whole, this unit contains PBFs 1, 2, 3, and 5, but PBF 4 is in degraded condition. PBFs 6 and 7 do not apply to this unit. Northern Mexican gartersnakes have been found in the Big Sandy River in 2010, 2015, and 2016 and in the Santa Maria River in 2015 and 2016 (Cotten 2015a and 2015b; Partridge 2015; O’Donnell et al. 2016; Sullivan et al. 2016; and Holycross et al. 2020). This unit contains lowland leopard frogs (Rana yavapaiensis), and native fish appear to be largely absent, although longfin dace (Agosia chrysogaster) have been detected in the Santa Maria River Subunit. Crayfish and several species of nonnative, spinyrayed fish maintain populations in reaches of the three rivers included in the Bill Williams River Subbasin Unit. The PBFs in this unit may require special management due to competition with, and predation by, nonnative species that are present in this unit and flood-control projects. We have excluded the entire Bill Williams River Subunit, including 1,476 ac (597 ha) of Federal, State, and private lands within the Lower Colorado River MSCP boundary, and 329 ac (133 ha) of AGFD’s Planet Ranch Conservation and Wildlife Area property (see Exclusions, below). Unit 5: Arivaca Cienega Unit Unit 5 consists of 211 ac (86 ha), along 3 stream mi (5 km) of Arivaca Creek within Arivaca Cienega. The Arivaca Cienega Unit is generally located in southern Arizona, in and around the town of Arivaca in Pima County, Arizona. This unit occurs on lands managed by the Service at Buenos Aires NWR, Arizona State Land Department, and private landowners. Drought, bullfrogs, and crayfish are a concern in the Arivaca Cienega Unit. Unit 5 is designated as critical habitat because it was occupied at the time of listing and as a whole, this unit contains PBFs 2 and 5, but PBFs 1, 3, and 4 are in degraded condition. PBFs 6 and 7 do not apply to this unit. Northern Mexican gartersnakes were found in Arivaca Cienega in 2000 (Rosen et al. 2001). The PBFs in this unit may require special management due to loss of perennial flow, as well as competition with, and predation by, nonnative species that are present in this unit. Unit 6: Cienega Creek Subbasin Unit Unit 6 consists of 2,083 ac (843 ha) along 46 stream mi (73 km) in four subunits: 30 stream mi (48 km) of Cienega Creek; 7 stream mi (12 km) of Empire Gulch, including Empire Wildlife Pond; 2 stream mi (3 km) of an unnamed drainage to Gaucho Tank, including Gaucho Tank; and 7 stream mi (11 km) of Gardner Canyon, including Maternity Wildlife Pond. The Cienega Creek

Subbasin Unit is generally located in southern Arizona, southeast of the city of Tucson and town of Vail, north of the town of Sonoita, west of the Rincon Mountains, and east of the Santa Rita Mountains in Pima County. The unnamed drainage to Gaucho Tank is an ephemeral channel that may serve as a movement corridor for northern Mexican gartersnakes. The Cienega Creek Subbasin Unit occurs on lands managed by BLM on Las Cienegas National Conservation Area (NCA), Arizona State Land Department, Pima County on Cienega Creek Preserve, and private landowners. Recent, ongoing bullfrog eradication on and around Las Cienegas NCA has reduced the threat of bullfrogs in much of this unit. Unit 6 is designated as critical habitat because it was occupied at the time of listing and as a whole, this unit contains PBFs 1, 2, 3, 5, 6, and 7, but PBF 4 is in degraded condition. Northern Mexican gartersnakes have been found in Cienega Creek at the Cienega Creek Pima County Preserve and Las Cienegas NCA in 2000, 2001, and 2011; Empire Wildlife Pond in 2016, Gaucho Tank in 2017, and Maternity Wildlife Pond in 2015 (Rosen et al. 2001, Appendix 1; Caldwell 2012, pers. comm.; Hall 2012, pers. comm.; Hall 2016, pers. comm.; Hall 2017, pers. comm.; Hall 2019, pers. comm; Simms 2019, pers. comm.; and Holycross et al. 2020, p. 717). Special management may be required to continue to promote the recovery or expansion of native leopard frogs and fish, continue bullfrog management, and eliminate or reduce other predatory nonnative species.   Unit 7: Upper Santa Cruz River Subbasin Unit Unit 7 consists of 380 ac (154 ha) along 14 stream mi (23 km) in seven subunits: FS 799 Tank; 5 stream mi (8 km) of Sonoita Creek; 4 stream mi (7 km) of Scotia Canyon; 2 stream mi (3 km) of Cott Tank Drainage; 2 stream mi (3 km) of Santa Cruz River; 2 stream mi (4 km) of an unnamed drainage to Pasture 9 Tank; and 0.6 stream mi (1 km) of an unnamed drainage to Sheehy Spring. The latter two unnamed drainages are ephemeral channels that may serve as movement corridors for northern Mexican gartersnakes. The Upper Santa Cruz River Subbasin Unit is generally located in southern Arizona, south of the town of Sonoita and within the town of Patagonia, southeast of the Santa Rita Mountains, and west of the Patagonia Mountains in Santa Cruz and Cochise Counties. The Upper Santa Cruz River Subbasin Unit occurs on lands managed by Coronado National Forest, Arizona State Parks at San Rafael State Natural Area, Arizona State Land Department, The Nature Conservancy, and private landowners. Unit 7 is designated as critical habitat because it was occupied at the time of listing and as a whole, this unit contains PBFs 1, 2, 3, 5, 6, and 7, but PBF 4 is in degraded condition. Northern Mexican gartersnakes have been found in FS 799 Tank in 2007, 2016, and 2018; Sonoita Creek in 2013; Scotia Canyon from 2000 to 2018; Cott Tank Drainage in 2008; Santa Cruz River in 2006 to 2018; Pasture 9 Tank in 2012; and Sheehy Spring in 2000 (Rosen et al. 2001, Table 4; Holycross et al. 2006, Appendix A; Frederick 2008, pers. comm.; Jones 2007, pers. comm; Jones 2013, pers. comm.; Jones 2009, pers. comm.; Servoss 2009, pers. comm.; Servoss 2018, pers. comm.; Akins 2012, pers. comm.; Lashway 2012, p. 5; Lashway 2014, p. 4; Lashway 2015, p. 4; Timmons 2014, pers. comm.; Timmons 2017, pers. comm.; Bookwalter 2014, pers. comm.; Cotten 2016, pers. comm.; Sorensen 2016, pers. comm.; Aaron 2017, pers. comm.; Ryan 2018, pers. comm.; and Holycross et al. 2020, p. 717). Native fish, American bullfrogs (Rana catesbeiana), tiger salamanders (Ambystoma spp.), and Chiricahua leopard frogs (Rana chiricahuensis) provide prey for northern Mexican gartersnakes in the Upper Santa Cruz River Subbasin Unit. Bullfrogs and nonnative, spiny-ray fish remain an issue in this unit. Special management may be required to continue to promote the recovery or expansion of native leopard frogs and fish and eliminate or reduce predatory nonnative species. We have excluded 0.2 ac (0.1 ha) of State lands within the 60-ft (18-m) Roosevelt Reservation from the Santa Cruz River Subunit. We have also excluded a total of 116 ac (47 ha) of private lands within the following subunits: San Rafael Cattle Company's San Rafael Ranch in the Santa Cruz River Subunit, Unnamed Drainage to Pasture 9 Tank Subunit, and Unnamed Drainage to Sheehy Spring Subunit; and Unnamed Wildlife Pond Subunit. Unit 8: Upper San Pedro River Subbasin Unit Unit 8 consists of 5,834 ac (2,361 ha) in six subunits along 35 stream mi (56 km): 22 stream mi (35 km) of the San Pedro River; 6 stream mi (10 km) of the Babocomari River; 4 stream mi (6 km) in O'Donnell Canyon; 3 stream mi (km) in Post Canyon; 0.4 stream mi (0.6 km) in an unnamed drainage and Finley Tank, and House Pond. The Upper San Pedro River Subbasin Unit is generally located in southeastern Arizona, east and west of Sierra Vista and south of the town of Elgin, in Cochise and Santa Cruz Counties. The Upper San Pedro River Subbasin Unit occurs primarily on lands managed by BLM on the San Pedro River Riparian and Las Cienegas NCAs, and also includes lands managed by the U.S. Forest Service on Coronado National Forest, Arizona State Land Department, and private entities. The unit includes portions of the Canelo Hills Preserve owned by The Nature Conservancy and the Appleton-Whittell Research Ranch owned by Audubon Society and Federal landowners. Unit 8 is designated as critical habitat because it was occupied at the time of listing and, as a whole, this unit contains PBFs 1, 2, 5, 6, and 7, but PBFs 3 and 4 are in degraded condition. Northern Mexican gartersnakes have been found in the San Pedro River near Highway 82 and State Route 90 in 2006 and 2018, Babocomari River in 2007 and 2009, O'Donnell Canyon on the Appleton-Whittell Research Ranch from 2000 to 2015, Post Canyon in 2009, Finley Tank in 2000, 2007 to 2009, and 2014; and House Pond in 2014 (Rosen et al. 2001, Appendix 1; Miscione 2009, pers. comm.; d'Orgeix 2011; d'Orgeix et al. 2013; Cogan 2014, pers. comm.; Cogan 2015, pers. comm.; Deecken 2014, pers. comm.; Miscione 2017, pers. comm.; and Ohlenkamp 2018, pers. comm.). Native fish and leopard frogs occur in House Pond, O'Donnell Canyon, and Post Canyon subunits and provide a prey base for northern Mexican gartersnakes. Crayfish, bullfrogs, and nonnative, spiny-rayed fish occur in the San Pedro River and Babocomari subunits and are an ongoing threat to northern Mexican gartersnakes. The PBFs in the Upper San Pedro River Subbasin Unit may require special management due to competition with, and predation by, predatory nonnative species that are present in this unit. We have excluded a total of 15 ac (6 ha) owned by a private ranch in the Post Canyon Subunit (see Exclusions, below). (USFWS, 2021)

Primary Constituent Elements/Physical or Biological Features

(1) Critical habitat units are depicted for La Paz, Mohave, Yavapai, Gila, Cochise, Santa Cruz, and Pima Counties in Arizona, and in Grant County in New Mexico, on the maps in this entry. (2) Within these areas, the physical or biological features essential to the conservation of northern Mexican gartersnake consist of the following components: (i) Perennial or spatially intermittent streams that provide both aquatic and terrestrial habitat that allows for immigration, emigration, and maintenance of population connectivity of northern Mexican gartersnakes and contain: (A) Slow-moving water (walking speed) with in-stream pools, off-channel pools, and backwater habitat; (B) Organic and natural inorganic structural features (e.g., boulders, dense aquatic and wetland vegetation, leaf litter, logs, and debris jams) within the stream channel for thermoregulation, shelter, foraging opportunities, and protection from predators; (C) Terrestrial habitat adjacent to the stream channel that includes riparian vegetation, small mammal burrows, boulder fields, rock crevices, and downed woody debris for thermoregulation, shelter, foraging opportunities, brumation, and protection from predators; and (D) Water quality that meets or exceeds applicable State surface water quality standards. (ii) Hydrologic processes that maintain aquatic and terrestrial habitat through: (A) A natural flow regime that allows for periodic flooding, or if flows are modified or regulated, a flow regime that allows for the movement of water, sediment, nutrients, and debris through the stream network; and (B) Physical hydrologic and geomorphic connection between a stream channel and its adjacent riparian areas. (iii) A combination of amphibians, fishes, small mammals, lizards, and invertebrate species such that prey availability occurs across seasons and years. (iv) An absence of nonnative fish species of the

families Centrarchidae and Ictaluridae, American bullfrogs (Lithobates catesbeianus), and/or crayfish (Orconectes virilis, Procambarus clarki, etc.), or occurrence of these nonnative species at low enough levels such that recruitment of northern Mexican gartersnakes is not inhibited and maintenance of viable prey populations is still occurring. (v) Elevations from 130 to 8,497 feet (40 to 2,590 meters). (vi) Lentic wetlands including offchannel springs, cienegas, and natural and constructed ponds (small earthen impoundment) with: (A) Organic and natural inorganic structural features (e.g., boulders, dense aquatic and wetland vegetation, leaf litter, logs, and debris jams) within the ordinary high water mark for thermoregulation, shelter, foraging opportunities, brumation, and protection from predators; (B) Riparian habitat adjacent to ordinary high water mark that includes riparian vegetation, small mammal burrows, boulder fields, rock crevices, and downed woody debris for thermoregulation, shelter, foraging opportunities, and protection from predators; and (C) Water quality that meets or exceeds applicable State surface water quality standards. (vii) Ephemeral channels that connect perennial or spatially intermittent perennial streams to lentic wetlands in southern Arizona where water resources are limited. (3) Critical habitat does not include humanmade structures (such as buildings, aqueducts, runways, roads, and other paved areas) and the land on which they are located existing within the legal boundaries on May 28, 2021. (4) Data layers defining map units were created included using the U.S. Geological Survey's 7.5′ quadrangles, National Hydrography Dataset, and National Elevation Dataset; the Service's National Wetlands Inventory dataset; and aerial imagery from Google Earth Pro. Line locations for lotic streams (flowing water) and drainages are depicted as the ''Flowline'' feature class from the National Hydrography Dataset geodatabase. Point locations for lentic sites (ponds) are depicted as ''NHDPoint'' feature class from the National Hydrography Dataset geodatabase. Extent of riparian habitat surrounding lotic streams and lentic sites is depicted by the greater of the ''Wetlands'' and ''Riparian'' features classes of the Service's national Wetlands Inventory dataset and further refined using aerial imagery from Google Earth Pro. Elevation range is masked using the ''Elev_Contour'' feature class of the National Elevation Dataset. Administrative boundaries for Arizona and New Mexico were obtained from the Arizona Land Resource Information Service and New Mexico Resource Geographic Information System, respectively. This includes the most current (as of May 28, 2021) geospatial data available for land ownership, counties, States, and streets. Locations depicting critical habitat are expressed as decimal degree latitude and longitude in the World Geographic Coordinate System projection using the 1984 datum (WGS84). The maps in this entry, as modified by any accompanying regulatory text, establish the boundaries of the critical habitat designation. The coordinates or plot points or both on which each map is based are available to the public at the Service's internet site at http://www.fws.gov/southwest/es/ arizona/, at http://www.regulations.gov at Docket No. FWS–R2–ES–2020–0011, and at the field office responsible for this designation. You may obtain field office location information by contacting one of the Service regional offices, the addresses of which are listed at 50 CFR 2.2. (USFWS, 2021)

Life History

Feeding Narrative

Adult: The northern Mexican gartersnake is an active predator and is believed to heavily depend upon a native prey base (Rosen and Schwalbe 1988, pp. 18, 20). Northern Mexican gartersnakes forage generally along vegetated banklines, searching for prey in water and on land, using different strategies (Alfaro 2002, p. 209). Generally, its diet consists predominantly of amphibians and fishes, such as adult and larval native leopard frogs (e.g., lowland leopard frog (Rana yavapaiensis) and Chiricahua leopard frog (Rana chiricahuensis)), as well as juvenile and adult native fish species (e.g., Gila topminnow (Poeciliopsis occidentalis occidentalis), desert pupfish (Cyprinodon macularius), Gila chub (Gila intermedia), and roundtail chub (Gila robusta)) (Rosen and Schwalbe 1988, p. 18). Auxiliary prey items may also include young Woodhouse's toads (Bufo woodhousei), treefrogs (Family Hylidae), earthworms, deermice (Peromyscus spp.), lizards of the genera Aspidoscelis and Sceloporus, larval tiger salamanders (Ambystoma tigrinum), and leeches (Gregory et al. 1980, pp. 87, 90–92; Rosen and Schwalbe 1988, p. 20; Holm and Lowe 1995, pp. 30–31; Degenhardt et al. 1996, p. 318; Rossman et al. 1996, p. 176; Manjarrez 1998). To a much lesser extent, this snake's diet may include nonnative species, including larval and juvenile bullfrogs, and mosquitofish (Gambusia affinis) (Holycross et al. 2006, p. 23). Venegas- Barrera and Manjarrez (2001, p. 187) reported the first observation of a snake in the natural diet of any species of Thamnophis after documenting the consumption by a Mexican gartersnake of a Mexican alpine blotched gartersnake (Thamnophis scalaris).

Reproduction Narrative

Adult: Sexual maturity in northern Mexican gartersnakes occurs at 2 years of age in males and at 2 to 3 years of age in females (Rosen and Schwalbe 1988, pp. 16–17). Northern Mexican gartersnakes are viviparous (bringing forth living young rather than eggs). Mating has been documented in April and May followed by the live birth of between 7 and 38 newborns (average is 13.6) in July and August (Rosen and Schwalbe 1988, p. 16; Nowak and Boyarski 2012, pp. 351–352). However, field observations in Arizona provide preliminary evidence that mating may also occur during the fall, but further research is required to confirm this hypothesis (Boyarski 2012, pers. comm.). Unlike other gartersnake species, which typically breed annually, one study suggests that only half of the sexually mature females within a population of northern Mexican gartersnake might reproduce in any one season (Rosen and Schwalbe 1988, p. 17). This may have negative implications for the species' ability to rebound in isolated populations facing threats such as nonnative species, habitat modification or destruction, and other perturbations. Low birth rates will impede recovery of such populations by accentuating the effects of these threats.

Geographic or Habitat Restraints or Barriers

Adult: Lack of wetland, riparian habitat

Environmental Specificity

Adult: High

Tolerance Ranges/Thresholds

Adult: Surface active at ambient temperatures ranging from 71 degrees Fahrenheit (°F) to 91 °F (22 degrees Celsius (°C) to 33 °C).

Site Fidelity

Adult: High

Habitat Narrative

Adult: The northern Mexican gartersnake is considered a riparian obligate (restricted to riparian areas when not engaged in dispersal behavior) and occurs chiefly in the following general habitat types: (1) Source-area wetlands [e.g., cienegas (mid-elevation wetlands with highly organic, reducing (basic, or alkaline) soils), stock tanks (small earthen impoundment), etc.]; (2) large river riparian woodlands and forests; and (3) streamside gallery forests (as defined by well-developed broadleaf deciduous riparian forests with limited, if any, herbaceous ground cover or dense grass). In the northern part of the range, the species is usually found in or near water in highland canyons with pine-oak forest and pinyon-juniper woodland, and it also enters mesquite grassland and desert areas, especially along valleys and stream courses (Stebbins 2003). The northern Mexican gartersnake is surface active at ambient temperatures ranging from 71 degrees Fahrenheit (°F) to 91 °F (22 degrees Celsius (°C) to 33 °C).

Dispersal/Migration

Motility/Mobility

Adult: Low

Migratory vs Non-migratory vs Seasonal Movements

Adult: Non-migrant

Dispersal/Migration Narrative

Adult: No information other than the species is non-migratory and populations rely on recruitment through reproduction to be sustainable.

Population Information and Trends

Population Trends:

Declining

Species Trends:

Declining

Population Growth Rate:

Unknown

Number of Populations:

21 to 300 rangewide; roughly 29 occurrences remain in the United States (Rosen et al. 2001, Center for Biological Diversity 2003); many more exist in the major portion of the range in Mexico. (NatureServe 2015).

Population Size:

2,500 to 100,000 individuals rangewide; 1,763 to 2938 individuals in AZ

Minimum Viable Population Size:

Unknown

Resistance to Disease:

Unknown

Adaptability:

Unknown

Additional Population-level Information:

Variability in survey design and effort makes it difficult to compare population trends among sites and between sampling periods. Thus, for each of the sites considered in our analysis, we have attempted to translate and quantifysearch and capture efforts into comparable units (i.e., person-search hours and trap-hours) and have cautiously interpreted those results. Given the data provided, it is not possible to determine population densities at the sites.

Population Narrative:

Variability in survey design and effort makes it difficult to compare population trends among sites and between sampling periods. Thus, for each of the sites considered in our analysis, we have attempted to translate and quantifysearch and capture efforts into comparable units (i.e., person-search hours and trap-hours) and have cautiously interpreted those results. Given the data provided, it is not possible to determine population densities at the sites. A detailed status of the northernAt the northern fringe of the range, United States populations have disappeared or declined in a large portion of the historical range (USFWS 2008). In New Mexico, a highly peripherel part of the known range, the species was historically recorded in just a few locations in two drainage systems but apparently now occurs in just one locality at most (New Mexico Department of Game and Fish 1997, Center for Biological Diversity 2003, USFWS 2008). In Arizona, substantial range contraction has been noted and fairly well documented, with populations extirpated at several locations since 1950 (Kulby 1995, Arizona Game and Fish Department 1998, Rosen et al. 2001, USFWS 2008). In southeastern Arizona, Rosen et al. (2001) found major declines at 2 sites, negative trends at 14 sites, possible stability at 2, and recolonization of habitat at one site. Subsequent surveys summarized by USFWS (2008) confirm the ongoing decline in Arizona. We have concluded that in as many as 24 of 29 known localities in the United States (83 percent), the northern Mexican gartersnake population is likely not viable and may exist at low population densities that could be threatened with extirpation or may already be extirpated. In most localities where the species may occur at low population densities, existing survey data are insufficient to prove extirpation. Only five populations of northern Mexican gartersnakes in the United States are considered likely viable where the species remains reliably detected. When considering the total number of stream miles in the United States that historically supported the northern Mexican gartersnake that are now permanently dewatered (except in the case of temporary flows in response to heavy precipitation), we concluded that as much as 90 percent of historical populations in the United States either occur at low densities or are extirpated. Listed as threatened throughout its range in Mexico by the Mexican Government, our understanding of the northern Mexican gartersnake's specific population status throughout its range in Mexico is less precise than that known for its United States distribution because survey efforts are less, and sufficient, available records do not exist or are difficult to obtain.

Threats and Stressors

Stressor: Modification and loss of cienegas
Exposure: Not assessed; see narrative.
Response: Not assessed; see narrative.
Consequence: Not assessed; see narrative.
Narrative: Cienegas are particularly important habitat for the northern Mexican gartersnake and are considered ideal for the species (Rosen and Schwalbe 1988, p. 14). Hendrickson and Minckley (1984, p. 131) defined cienegas as ‘‘midelevation (3,281–6,562 ft (1,000–2000 m)) wetlands characterized by permanently saturated, highly organic, reducing [lowering of oxygen level]

soils.'' Many of these unique communities of the southwestern United States, Arizona in particular, and Mexico have been lost in the past century to streambed modification, improper livestock grazing, woodcutting, artificial drainage structures, stream flow stabilization by upstream dams, channelization, and stream flow reduction from groundwater pumping and water diversions (Hendrickson and Minckley 1984, p. 161).

Stressor: Nonnative shrub species
Exposure: Not assessed; see narrative.
Response: Not assessed; see narrative.
Consequence: Not assessed; see narrative.
Narrative: Nonnative shrub species in the genus Tamarix, such as salt cedar, have been widely introduced throughout the western States and appear to thrive in regulated river systems (Stromberg and Chew 2002, pp. 210–213). Tamarix invasions may result in habitat alteration from potential effects to water tables, changes to canopy and ground vegetation structures, and increased fire risk, which hasten the loss of native cottonwood and willow communities and affect the suitability of the vegetation component to northern Mexican gartersnake habitat (Stromberg and Chew 2002, pp. 211–212; USFWS 2002b, p. H–9).

Stressor: Urban and rural development
Exposure: Not assessed; see narrative.
Response: Not assessed; see narrative.
Consequence: Not assessed; see narrative.
Narrative: Development within and adjacent to riparian areas has proven to be a significant threat to riparian biological communities and their suitability for native species (Medina 1990, p. 351). Riparian communities are sensitive to even low levels (less than 10 percent) of urban development within a watershed (Wheeler et al. 2005, p. 142). Development along or within proximity to riparian zones can alter the nature of stream flow dramatically, changing once-perennial streams into ephemeral streams, which has direct consequences on the riparian community (Medina 1990, pp. 358–359) and, within occupied habitat, the northern Mexican gartersnake. Medina (1990, pp. 358–359) concluded that perennial streams had greater tree densities in all diameter size classes of Alnus oblongifolius (Arizona alder) and Acer negundo (box elder) as compared to ephemeral reaches where small-diameter trees were absent. Small diameter trees assist the northern Mexican gartersnake by providing additional habitat complexity and cover needed to reduce predation risk and enhance the usefulness of areas for maintaining optimal body temperature.

Stressor: Groundwater pumping, surface water diversions and flood control
Exposure: Not assessed; see narrative.
Response: Not assessed; see narrative.
Consequence: Not assessed; see narrative.
Narrative: Water quality and quantity are being affected by ongoing activities in the United States and Mexico. Due to the reliance of the northern Mexican gartersnake on ecosystems and communities supported by permanent water sources, these threats are significant to the survival and viability of existing and future northern Mexican gartersnake populations.

Stressor: Improper livestock grazing and agricultural uses
Exposure: Not assessed; see narrative.
Response: Not assessed; see narrative.

Consequence: Not assessed; see narrative.
Narrative: Poor livestock management causes a decline in diversity, abundance, and species composition of riparian herpetofauna communities from direct or indirect threats to the prey base, the habitat, or to the northern Mexican gartersnake. These effects include: (1) Declines in the structural richness of the vegetation community; (2) losses or reductions of the prey base; (3) increased aridity of habitat; (4) loss of thermal cover and protection from predators; and (5) a rise in water temperatures to levels lethal to larval stages of amphibian and fish development (Szaro et al. 1985, p. 362; Schulz and Leininger 1990, p. 295; Belsky et al. 1999, pp. 8–11). Improper livestock grazing may also lead to desertification (the process of becoming arid land or desert as a result of land mismanagement or climate change) due to a loss in soil fertility from erosion and gaseous emissions spurred by a reduction in vegetative ground cover (Schlesinger et al. 1990, p. 1043).

Stressor: High intensity wildfires
Exposure: Not assessed; see narrative.
Response: Not assessed; see narrative.
Consequence: Not assessed; see narrative.
Narrative: Existing wildfire suppression policies intended to protect the expanding number of human structures on forested public lands have altered the fuel loads in these ecosystems and increased the probability of devastating wildfires. The effects of these catastrophic wildfires include the removal of vegetation, the degradation of watershed condition, altered stream behavior, increased sedimentation of streams, and population explosions of nonnative grasses, which, in addition to having an effect on native vegetation communities, lead to increased fire frequency.

Stressor: Nonnative species interactions
Exposure: Not assessed; see narrative.
Response: Not assessed; see narrative.
Consequence: Not assessed; see narrative.
Narrative: Nonnative species represent the most serious threat to the northern Mexican gartersnake through direct predation and predation on northern Mexican gartersnake prey (competition). Nonnative species, such as the bullfrog, the northern (virile) crayfish (Orconectes virilis) and red swamp (Procambarus clarki) crayfish, and numerous species of nonnative sport and bait fish species continue to be the most significant threat to the northern Mexican gartersnake and to its prey base from direct predation, competition, and modification of habitat

Stressor: Declines in native prey base (frogs and fish)
Exposure: Not assessed; see narrative.
Response: Not assessed; see narrative.
Consequence: Not assessed; see narrative.
Narrative: Declines in the native leopard frog populations in Arizona have contributed to declines in the northern Mexican gartersnake as a primary native predator. Native ranid frog species such as lowland leopard frogs, northern leopard frogs, and federally threatened Chiricahua leopard frogs have all experienced significant declines throughout their distribution in the Southwest, partially due to predation and competition with nonnative species. Native fish species such as the federally endangered Gila chub, roundtail chub (a species petitioned for Federal listing), and federally endangered Gila topminnow historically were among the primary prey species for the northern Mexican gartersnake (Rosen and Schwalbe 1988, p. 18). Northern Mexican gartersnakes

depend on native fish as a principle part of their prey base, although nonnative mosquitofish may also be taken as prey (Holycross et al. 2006, p. 23). Both nonnative sport and bait fish compete with the northern Mexican gartersnake in terms of its native fish and native anuran prey base. Collier et al. (1996, p. 16) note that interactions between native and nonnative fish have significantly contributed to the decline of many native fish species from direct predation and indirectly from competition (which has adversely affected the prey base for northern Mexican gartersnakes).

Stressor: Bullfrogs
Exposure: Not assessed; see narrative.
Response: Not assessed; see narrative.
Consequence: Not assessed; see narrative.
Narrative: Bullfrogs are widely considered one of the most serious threats to the northern Mexican gartersnake throughout its range (Conant 1974, pp. 471, 487–489; Rosen and Schwalbe 1988, pp. 28–30; Rosen et al. 2001, pp. 21–22). Bullfrogs adversely affect northern Mexican gartersnakes through direct predation of juveniles and sub-adults and from competition with native prey species. Sub-adult and adult bullfrogs not only compete with the northern Mexican gartersnake for prey items, but directly prey upon juvenile and occasionally sub-adult northern Mexican gartersnakes (Rosen and Schwalbe 1988, pp. 28–31; 1995, p. 452; 2002b, pp. 223–227; Holm and Lowe 1995, pp. 29–29; Rossman et al. 1996, p. 177; AGFD In Prep, p. 12; 2001, p. 3; Rosen et al. 2001, pp. 10, 21–22; Carpenter et al. 2002, p. 130; Wallace 2002, p. 116).

Stressor: Nonnative crayfish
Exposure: Not assessed; see narrative.
Response: Not assessed; see narrative.
Consequence: Not assessed; see narrative.
Narrative: Nonnative crayfish are a primary threat to many prey species of the northern Mexican gartersnake and may also prey upon juvenile gartersnakes (Fernandez and Rosen 1996, p. 25; Voeltz 2002, pp. 87–88; USFWS 2007, p. 22). Fernandez and Rosen (1996, p. 3) studied the effects of crayfish introductions on two stream communities in Arizona, a low elevation semi-desert stream and a high mountain stream, and concluded that crayfish can noticeably reduce species diversity and destabilize food chains in riparian and aquatic ecosystems through their effect on vegetative structure, stream substrate (stream bottom; i.e., silt, sand, cobble, boulder) composition, and predation on eggs, larval, and adult forms of native invertebrate and vertebrate species.

Stressor: Climate change
Exposure: Not assessed; see narrative.
Response: Not assessed; see narrative.
Consequence: Not assessed; see narrative.
Narrative: Changes to climatic patterns are predicted to have implications for the effect of, and management for, nonnative species within the distribution of the northern Mexican gartersnake. Based upon climate change models, nonnative species biology, and ecological observations, Rahel et al. (2008, p. 551) conclude that climate change could foster the expansion of nonnative aquatic species into new areas, magnify the effects of existing aquatic nonnative species where they currently occur, increase nonnative predation rates, and heighten the virulence of disease outbreaks in North America. Many of the nonnative species have similar, basic ecological requirements as our native species, such as the need for permanent or nearly permanent water.

Therefore, it is likely that effects from changes to climatic patterns (such as a trend towards a more arid environment) that negatively affect nonnative species such as bullfrogs and nonnative fish may also negatively affect native prey species for the northern Mexican gartersnake. Changes to climatic patterns may warm water temperatures, alter stream flow events, and may increase demand for water storage and conveyance systems (Rahel and Olden 2008, pp. 521–522). Warmer water temperatures across temperate regions are predicted to expand the distribution of existing aquatic nonnative species by providing 31 percent more suitable habitat for aquatic nonnative species, which are often tropical in origin and adaptable to warmer water temperatures. The effects of the water withdrawals may be exacerbated by the current, long-term drought facing the arid southwestern United States.

Recovery

Delisting Criteria:
Not developed.

Recovery Actions:
- Not developed.

References

2015 NatureServe. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://explorer.natureserve.org. (Accessed: July 7, 2015)

USFWS 2013. Endangered and Threatened Wildlife and Plants. Threatened Status for the Northern Mexican Gartersnake and Narrow-headed Gartersnake. U.S. Fish and Wildlife Service, Proposed Rule. July 10, 2013. Federal Register 78 (132), pp. 41500-41547

USFWS 2008. Endangered and Threatened Wildlife and Plants. 12-Month Finding on a Petition To List the Northern Mexican Gartersnake (Thamnophis eques megalops) as Threatened or Endangered with Critical Habitat. U.S. Fish and Wildlife Service, Federal Register 73 (228), November 25, 2008, pp. 71788-71826

USFWS. 2021. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for the Northern Mexican Gartersnake. Final Rule. FR Vol. 86, No. 80. Pages 22518-22580.

2015 NatureServe. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://explorer.natureserve.org. (Accessed: July 7, 2015).

USFWS. 2008. Endangered and Threatened Wildlife and Plants. 12-Month Finding on a Petition To List the Northern Mexican Gartersnake (Thamnophis eques megalops) as Threatened or Endangered with Critical Habitat. U.S. Fish and Wildlife Service, 73 Federal Register 228, November 25, 2008, pp. 71788-71826.

USFWS. 2008. Endangered and Threatened Wildlife and Plants. 12-Month Finding on a Petition To List the Northern Mexican Gartersnake (Thamnophis eques megalops) as Threatened or Endangered with Critical Habitat. U.S. Fish and Wildlife Service, Federal Register 73 (228), November 25, 2008, pp. 71788-71826

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

Yes;

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; the short-term population-level trend is a decline of 10 to 30 percent. The long-term population-level trend is a decline of 30 to 50 percent (NatureServe 2015).

Species Trends:

Declining

Population Growth Rate:

Slow decline

Number of Populations:

6 to 20 populations (NatureServe 2015). Of the 13 populations identified in the listing and the draft recovery plan (published in 1999), two are presumed extirpated and three have been combined into a single population, leaving nine extant populations identified by surveys conducted in 2011 (USFWS 2012).

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).

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.

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:

-
-

References

58 FR 54053. Endangered and Threatened Wildlife and Plants, Determination of Threatened Status for the Giant Garter Snake. Final Rule. Vol. 58. No. 201. Federal Register 54053. October 20, 1993. Rules and Regulations. Accessed on: October 29, 2015. Available online at: http://ecos.fws.gov/docs/federal_register/fr2446.pdf

NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Thamnophis gigas. Giant garter snake. Available online at: http://explorer.natureserve.org/servlet/NatureServe?searchName=Thamnophis+gigas. Date accessed: October 22, 2015

USFWS (U.S. Fish and Wildlife Service). 1999. Draft Recovery Plan for the Giant Garter Snake (Thamnopsis gigas). Miller, Karen. Hornady, Kelly. U.S. Fish and Wildlife Service Sacramento Fish and Wildlife Office and The Giant Garter Snake Recovery Team. Available online at: http://ecos.fws.gov/docs/recovery_plan/990702b.pdf. Date accessed: October 29, 2015

USFWS (U.S. Fish and Wildlife Service). 2012. Giant Garter Snake (Thamnophis gigas) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Serve Sacramento Fish and Wildlife Office. Sacramento, California. June 2012. Available online at: http://ecos.fws.gov/docs/five_year_review/doc4009.pdf. Date accessed: October 22, 2015.

58 FR 54053. Endangered and Threatened Wildlife and Plants, Determination of Threatened Status for the Giant Garter Snake. Final Rule. Vol. 58. No. 201. Federal Register 54053. October 20, 1993. Rules and Regulations. Available online at: http://ecos.fws.gov/docs/federal_register/fr2446.pdf. Date accessed: October 29, 2015

USFWS (U.S. Fish and Wildlife Service). 1999. Draft Recovery Plan for the Giant Garter Snake (Thamnopsis gigas) Miller, Karen. Hornady, Kelly. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office and The Giant Garter Snake Recovery Team. Available online at: http://ecos.fws.gov/docs/recovery_plan/990702b.pdf. Date accessed: October 29, 2015

USFWS (U.S. Fish and Wildlife Service). 2012. Giant Garter Snake (Thamnophis gigas) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Serve Sacramento Fish and Wildlife Office. Sacramento, California. June 2012. Available online at: http://ecos.fws.gov/docs/five_year_review/doc4009.pdf. Date accessed: October 22, 2015

USFWS (U.S. Fish and Wildlife Service). 2015. Giant Garter Snake. Sacramento Fish and Wildlife Office. Available online at: http://www.fws.gov/sacramento/es_kids/Garter-Snake/es_kids_garter-snake.htm. Date accessed: October 29, 2015.

USFWS (U.S. Fish and Wildlife Service). 2012. Giant Garter Snake (Thamnophis gigas) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service. Sacramento Fish and Wildlife Office. Sacramento, California. June 2012. Available online at: http://ecos.fws.gov/docs/five_year_review/doc4009.pdf. Date accessed: October 22, 2015.

USFWS (U.S. Fish and Wildlife Service). 1999. Draft Recovery Plan for the Giant Garter Snake (Thamnopsis gigas). Miller, Karen

Hornady, Kelly

U.S. Fish and Wildlife Service Sacramento Fish and Wildlife Office and The Giant Garter Snake Recovery Team. Available online at: http://ecos.fws.gov/docs/recovery_plan/990702b.pdf. Date accessed: October 29, 2015

USFWS (U.S. Fish and Wildlife Service). 2012. Giant Garter Snake (Thamnophis gigas) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Sacramento Office. Sacramento, California. June 2012. Available online at: http://ecos.fws.gov/docs/five_year_review/doc4009.pdf. Date accessed: October 22, 2015.

USFWS. 2020. Giant Gartersnake (Thamnophis gigas) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Sacramento Fish and Wildlife Office Sacramento, California. 52 pp.

U.S. Fish and Wildlife Service Sacramento Fish and Wildlife Office and The Giant Garter Snake Recovery Team. Available online at: http://ecos.fws.gov/docs/recovery_plan/990702b.pdf. Date accessed: October 29, 2015.

U.S. Fish and Wildlife Service. 2017. Recovery Plan for the Giant Garter Snake (Thamnophis gigas). U.S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, California. vii + 71 pp.

USFWS (U.S. Fish and Wildlife Service). 1999. Draft Recovery Plan for the Giant Garter Snake (Thamnopsis gigas). Appendix C: Prepared by John M. Brode, Department of Fish and Wildlife, Inland Fisheries Division, October 1990. Sacramento Fish and Wildlife Office and The Giant Garter Snake Recovery Team. Available online at: http://ecos.fws.gov/docs/recovery_plan/990702b.pdf. Date accessed: November 19, 2015.

SPECIES ACCOUNT: *Thamnophis rufipunctatus* (Narrow-headed garter snake)

Species Taxonomic and Listing Information

Listing Status: Threatened; 7/8/2014; Southwest Region (R2)

Physical Description

The narrow-headed gartersnake is a small to medium-sized gartersnake with a maximum total length of 44 in (112 cm mm) (Painter and Hibbitts 1996, p. 147). Its eyes are set high on its unusually elongated head, which narrows to the snout, and it lacks striping on the dorsum (top) and sides, which distinguishes its appearance from other gartersnake species with which it could co-occur (Rosen and Schwalbe 1988, p. 7). The base color is usually tan or greybrown (but may darken) with conspicuous brown, black, or reddish spots that become indistinct towards the tail (Rosen and Schwalbe 1988, p. 7; Boundy 1994, p. 126). The scales are keeled. Degenhardt et al. (1996, p. 327), Rossman et al. (1996, pp. 242–244), and Ernst and Ernst (2003, p. 416) further describe the species.

Taxonomy

Family Colubridae (Colubrids). Due to the narrow-headed gartersnake's morphology and feeding habits, there has been considerable deliberation among taxonomists about the correct association of this species within seven various genera over time (Rosen and Schwalbe 1988, pp. 5–6); chiefly, between the genera Thamnophis (the ''gartersnakes'') and Nerodia (the ''watersnakes'') (Pierce 2007, p. 5). Using mitochondrial DNA (mtDNA) genetic analyses (De Querioz and Lawson 1994, p. 217), inclusion of the narrow-headed gartersnake in the genus Nerodia has been refuted and the species is maintained within the genus Thamnophis.

Historical Range

The historical distribution of the narrow-headed gartersnake ranged across the Mogollon Rim and along its associated perennial drainages from central and eastern Arizona, southeast to southwestern New Mexico at elevations ranging from 2,300 to 8,000 ft (700 to 2,430 m) (Rosen and Schwalbe 1988, p. 34; Rossman et al. 1996, p. 242; Holycross et al. 2006, p. 3). The species was historically distributed in headwater streams of the Gila River subbasin that drain the Mogollon Rim and White Mountains in Arizona, and the Gila Wilderness in New Mexico; major subbasins in its historical distribution included the Salt and Verde River subbasins in Arizona, and the San Francisco and Gila River subbasins in New Mexico (Holycross et al. 2006, p. 3). Holycross et al. (2006, p. 3) suspect the species was likely not historically present in the lowest reaches of the Salt, Verde, and Gila rivers, even where perennial flow persists. Numerous records for the narrow-headed gartersnake (through 1996) in Arizona are maintained in the AGFD's Heritage Database (1996b). The narrow-headed gartersnake as currently recognized does not occur in Mexico.

Current Range

As of 2011, the only remaining narrow-headed gartersnake populations where the species could reliably be found were located at: (1) Whitewater Creek (New Mexico), (2) Tularosa River (New Mexico), (3) Diamond Creek (New Mexico), (4) Middle Fork Gila River (New Mexico), and (5) Oak CreekCanyon (Arizona). However, populations found in Whitewater Creek and the Middle Fork

Gila River were likely significantly affected by New Mexico’s largest wildfire in State history, the Whitewater-Baldy Complex Fire, which occurred in June 2012.

Distinct Population Segments Defined

No.

Critical Habitat Designated

Yes; 11/22/2021.

Legal Description

We, the U.S. Fish and Wildlife Service (Service), designate critical habitat for the narrow-headed gartersnake (Thamnophis rufipunctatus) under the Endangered Species Act of 1973 (Act), as amended. In total, 23,785 acres (9,625 hectares) in Greenlee, Apache, Yavapai, Gila, and Coconino Counties, Arizona, and Grant, Hidalgo, and Catron Counties, New Mexico, fall within the boundaries of the critical habitat designation for the narrowheaded gartersnake. This rule extends the Act’s protections to the narrowheaded gartersnake’s designated critical habitat. (USFWS, 2021)

Primary Constituent Elements/Physical or Biological Features

(1) Critical habitat units are depicted for Greenlee, Apache, Yavapai, Gila, and Coconino Counties in Arizona, as well as in Grant, Hidalgo, and Catron Counties in New Mexico, on the maps in this entry. (2) Within these areas, the physical or biological features essential to the conservation of narrow-headed gartersnake consist of the following components: (i) Perennial streams or spatially intermittent streams that provide both aquatic and terrestrial habitat that allows for immigration, emigration, and maintenance of population connectivity of narrow-headed gartersnakes and contain: (A) Pools, riffles, and cobble and boulder substrate, with a low amount of fine sediment and substrate embeddedness; (B) Organic and natural inorganic structural features (e.g., cobble bars, rock piles, large boulders, logs or stumps, aquatic vegetation, vegetated islands, logs, and debris jams) in the stream channel for basking, thermoregulation, shelter, prey base maintenance, and protection from predators; (C) Water quality that meets or exceeds applicable State surface water quality standards; and (D) Terrestrial habitat up to 328 feet (100 meters) from the active stream channel (water’s edge) that includes flood debris, rock piles, and rock walls containing cracks and crevices, small mammal burrows, downed woody debris, and streamside vegetation (e.g., alder, willow, sedges, and shrubs) for thermoregulation, shelter, brumation and protection from predators throughout the year. (ii) Hydrologic processes that maintain aquatic and riparian habitat through: (A) A natural flow regime that allows for periodic flooding, or if flows are modified or regulated, a flow regime that allows for the movement of water, sediment, nutrients, and debris through the stream network, as well as maintenance of native fish populations; and (B) Physical hydrologic and geomorphic connection between the active stream channel and its adjacent terrestrial areas. (iii) A combination of native fishes, and soft-rayed, nonnative fish species such that prey availability occurs across seasons and years. (iv) An absence of nonnative aquatic predators, such as fish species of the families Centrarchidae and Ictaluridae, American bullfrogs (Lithobates catesbeianus), and/or crayfish (Orconectes virilis, Procambarus clarki, etc.), or occurrence of these nonnative species at low enough levels such that recruitment of narrow-headed gartersnakes is not inhibited and maintenance of viable prey populations is still occurring. (v) Elevations of 2,300 to 8,200 feet (700 to 2,500 meters). (3) Critical habitat does not include manmade structures (such as buildings, aqueducts, runways, roads, and other paved areas) and the land on which they are located

existing within the legal boundaries on November 22, 2021. (4) Data layers defining map units were created using the U.S. Geological Survey's 7.5' quadrangles, National Hydrography Dataset and National Elevation Dataset; the Service's National Wetlands Inventory dataset; and aerial imagery from Google Earth Pro. Line locations for lotic streams (flowing water) and drainages are depicted as the ''Flowline'' feature class from the National Hydrography Dataset geodatabase. The active channel along a stream is depicted as the ''Wetlands'' feature class from the Service's National Wetlands Inventory dataset. Any discrepancies between the ''Flowline'' and ''Wetlands'' feature classes were resolved using aerial imagery from Google Earth Pro. Elevation range is masked using the ''Elev_Contour'' feature class of the National Elevation Dataset. The administrative boundaries for Arizona and New Mexico were obtained from the Arizona Land Resource Information Service and New Mexico Resource Geographic Information System, respectively. This includes the most current (as of November 22, 2021) geospatial data available for land ownership, counties, States, and streets. Locations depicting critical habitat are expressed as decimal degree latitude and longitude in the World Geographic Coordinate System projection using the 1984 datum (WGS84). The maps in this entry, as modified by any accompanying regulatory text, establish the boundaries of the critical habitat designation. The coordinates or plot points or both on which each map is based are available to the public at the Service's internet site at http://www.fws.gov/southwest/es/ arizona/, at http://www.regulations.gov at Docket No. FWS–R2–ES–2020–0011, and at the field office responsible for this designation. You may obtain field office location information by contacting one of the Service regional offices, the addresses of which are listed at 50 CFR 2.2. (USFWS, 2021)

Special Management Considerations or Protections

A detailed discussion of activities influencing the narrow-headed gartersnake and its habitat can be found in the final listing rule (79 FR 38678; July 8, 2014). All areas of critical habitat will require some level of management to address the current and future threats to the narrow-headed gartersnake and to maintain or restore the PBFs. Special management within critical habitat will be needed to ensure these areas provide adequate water quantity, quality, and permanence or near permanence; cover (particularly in the presence of nonnative aquatic predators); an adequate prey base; and absence of or low numbers of nonnative aquatic predators that can affect population persistence. Activities that may be considered adverse to the conservation benefits of critical habitat include those which: (1) Completely dewater or reduce the amount of water to unsuitable levels in critical habitat; (2) result in a significant reduction of protective cover within critical habitat when nonnative aquatic predator species are present; (3) remove or significantly alter structural terrestrial features of critical habitat that alter natural behaviors such as thermoregulation, brumation, gestation, and foraging; (4) appreciably diminish the prey base for a period of time determined to likely cause populationlevel effects; and (5) directly promote increases in nonnative aquatic predator populations, result in the introduction of nonnative aquatic predators, or result in the continued persistence of nonnative aquatic predators. Common examples of these activities may include, but are not limited to, various types of development, channelization, diversions, road construction, erosion control, bank stabilization, wastewater discharge, enhancement or expansion of human recreation opportunities, fish community renovations, and stocking of nonnative, spiny-rayed fish species or promotion of policies that directly or indirectly introduce nonnative aquatic predators as bait. The activities listed above are just a subset of examples that have the potential to affect critical habitat and PBFs if they are conducted within designated units; however, some of these activities, when conducted appropriately, may be compatible with maintenance of adequate PBFs or even improve upon their value over time. For activities planned within critical habitat, we encourage interested parties to contact the local Ecological Services field office (see FOR FURTHER INFORMATION CONTACT). Criteria Used To Identi (USFWS, 2021)

Life History

Feeding Narrative

Adult: The diet of the narrow-headed gartersnake is comprised almost entirely of fish (Fleharty 1967 p. 223, Rosen and Schwalbe 1988 p. 38, Pierce 2007 p. 8, USFWS 2013a p. 41506). The narrow-headed gartersnake relies on native fish species as its primary food resource (USFWS 2013a p. 41511). The most common native fish species taken by the narrow-headed gartersnake includes Sonora sucker, desert sucker, speckled dace, roundtail chub, gila chub, and headwater chub (Rosen and Schwalbe 1988 p. 39, USFWS 2013a p. 41507). This species will also consume nonnative trout, such as brown and rainbow, as well as other soft-rayed fish species as part of their diet in the absence of native species (Rosen and Schwalbe 1988 p. 39, USFWS 2013a p. 41507, 41510). While narrow-headed gartersnakes will eat nonnative species, the gartersnakes are only found in abundance in areas with abundant resources of native fish (Rosen and Schwalbe 1988 p. 44, USFWS 2013a p. 41511). Therefore, habitat-based attributes are important for the survival of fish prey species and are equally important for the survival of narrow-headed gartersnakes. The narrow-headed gartersnake uses the interstitial spaces between partially submerged rocks and boulders to ambush prey and shelter from predators (Rosen and Schwalbe 1988 p. 35, Pierce 2007 p. 7). The species may also use the surfaces of partially submerged rock and boulders to thermoregulate by basking (Rosen and Schwalbe 1988 p. 35). When hunting, the narrow-headed gartersnake uses its tail to anchor itself to rocks to hold its position in the current and ambush its prey (Hibbitts and Fitzgerald 2005 p. 364, Pierce 2007 p. 8).

Reproduction Narrative

Adult: Sexual maturity in narrow-headed gartersnakes occurs at 2.5 years of age in males and at 2 years of age in females (Deganhardt et al. 1996, p. 328). Narrow headed gartersnakes are viviparous. The reproductive cycle for narrow-headed gartersnakes appears to be longer than other gartersnake species; females begin the development of follicles in early March, and gestation takes longer (Rosen and Schwalbe 1988, pp. 36–37). Female narrow-headed gartersnakes breed annually and give birth to 4 to 17 offspring from late July into early August, perhaps earlier at lower elevations (Rosen and Schwalbe 1988, pp. 35–37). Sex ratios in narrowheaded gartersnake populations can be skewed in favor of females (Fleharty 1967, p. 212).

Geographic or Habitat Restraints or Barriers

Adult: Busy highway or highway with obstructions such that snakes rarely if ever cross successfully; major river, lake, pond, or deep marsh (this barrier pertains only to upland species and does not apply to aquatic or wetland snakes); densely urbanized area dominated by buildings and pavement. (NatureServe 2015)

Environmental Specificity

Adult: High

Tolerance Ranges/Thresholds

Adult: Found to be active in air temperatures ranging from 52 to 89 °F (11 to 32 °C) and water temperatures ranging from 54 to 72 °F (12 to 22 °C) (Nowak, 2006, Appendix 1). Narrow-headed gartersnakes have a lower preferred temperature for activity as compared to other species of gartersnakes (Fleharty 1967, p. 228), which may facilitate their highly aquatic nature in cold streams.

Habitat Narrative

Adult: Narrow-headed gartersnakes are widely considered to be one of the most aquatic gartersnake species (Rossman et al. 1996, p. 246), and are strongly associated with clear, rocky streams, using predominantly pool and riffle habitat that includes cobbles and boulders (Rosen and Schwalbe 1988, pp. 33–34; Degenhardt et al. 1996, p. 327; Rossman et al. 1996, p. 246). Narrow-headed gartersnakes occur at elevations from approximately 2,300–8,200 ft (700 m–2,500 m), inhabiting Petran Montane Conifer Forest, Great Basin Conifer Woodland, Interior Chaparral, and the Arizona Upland subdivision of Sonoran Desertscrub communities (Rosen and Schwalbe 1988, p. 33; Brennan and Holycross 2006, p. 122; Burger 2008). In addition to aquatic habitat, narrow-headed gartersnakes rely on terrestrial habitat for thermoregulation, gestation, shelter, protection from predators, immigration, emigration, and brumation (cold-season dormancy). Important terrestrial habitat components for the narrow-headed gartersnake include cobbles, boulders, and bankside shrub vegetation for basking and foraging (Fleharty 1967, pp. 215–216; Rosen and Schwalbe 1988, p. 48; Ernst and Ernst 2003, p. 418). Bankline vegetation is an essential component of suitable narrow-headed gartersnake habitat in the presence of harmful nonnative species (USFWS 2013a p. 41506). The species uses Petran Montane Conifer Forest, Great Basin Conifer Woodland, Interior Chapparral, and the Arizona Upland subdivision of Sonoran Desertscrub communities (Rosen and Schwalbe 1988 p. 33, USFWS 2013a p. 41506). The species thermoregulates by basking on vegetation close to the water, preferebly shrub and sapling sized plants (USFWS 2013a p. 41506) or other suitable surfaces. Willows that overhang the stream channel may be of particular importance to the species (Holycross et al. 2006 p. 51). Vegatation in close proximity to water affords the species an avenue of quick escape (Fleharty 1967 p. 216, USFWS 2013a p. 41506).

Dispersal/Migration

Motility/Mobility

Adult: Low

Migratory vs Non-migratory vs Seasonal Movements

Adult: Non-migrant

Dispersal/Migration Narrative

Adult: At least some snakes of the colubrid family (Colubridae), including medium-sized species such as gartersnakes, not uncommonly move between areas up to a few kilometers apart, and several species make extensive movements of up to several kilometers, so separation distances of 1-2 km for suitable habitat are too small for medium-sized and large colubrids.

Population Information and Trends

Population Trends:

Declining

Species Trends:

Declining

Population Growth Rate:
Low

Number of Populations:
In 2011, 38 known localities, of which 29 (76%) are considered to be non-viable. As of 2012, populations are considered likely viable in 3 localities (8 percent) where individuals are reliable detected.

Population Size:
Unknown

Minimum Viable Population Size:
Unknown

Resistance to Disease:
Unknown

Adaptability:
Uknown

Population Narrative:
The narrow-headed gartersnake has experienced significant declines in population density and distribution along streams and rivers where it was formerly well-documented and reliably detected. Many areas where the species may occur likely rely on emigration of individuals from occupied habitat into those areas to maintain the species, provided there are no barriers to movement. Narrow-headed gartersnakes have been detected in only 5 of 16 historical localities in Arizona and New Mexico surveyed by Holycross et al. (2006) in 2004 and 2005. Population densities have noticeably declined in many populations, as compared to previous survey efforts (Holycross et al. 2006, p. 66). As of 2011, the only remaining narrow-headed gartersnake populations where the species could reliably be found were located at: (1) Whitewater Creek (New Mexico), (2) Tularosa River (New Mexico), (3) Diamond Creek (New Mexico), (4) Middle Fork Gila River (New Mexico), and (5) Oak Creek Canyon (Arizona). It has been concluded that in as many as 29 of 38 known localities (76 percent), the narrow-headed gartersnake population is likely not viable and may exist at low population densities that could be threatened with extirpation or may already be extirpated but survey data are lacking in areas where access is restricted. In most localities where the species may occur at low population densities, existing survey data are insufficient to conclude extirpation. As of 2012, narrow-headed gartersnake populations are considered likely viable in 3 localities (8 percent) where individuals are reliable detected.

Threats and Stressors

Stressor: Predation and competion by harmful non-native species
Exposure: See narrative.
Response: See narrative.
Consequence: See narrative.

Narrative: Harmful nonnative species (e.g., bullfrogs, crayfish, and spiny-rayed fish) are the single most important threat to narrowheaded gartersnakes and their prey bases, and therefore have had a profound role in their decline. Harmful nonnative species have been intentionally introduced or have naturally moved into virtually every subbasin throughout the distribution of narrow-headed gartersnakes in the United States and Mexico. Native fish are important prey for narrow-headed gartersnakes. Predation by and competition with primarily nonnative, spiny-rayed fish species, and secondarily with crayfish, are widely considered to be the primary reason for major declines in native fish communities throughout the range of this gartersnake.

Stressor: Habitat and population fragmentation as a result of harmful nonnative species
Exposure:
Response:
Consequence:
Narrative: Unnatural levels of predation and competition associated with harmful nonnative species weakens resistance of the gartersnake to other threats, including those that affect the physical suitability of their habitat. This ultimately renders populations much less resilient to stochastic, natural, or anthropogenic stressors that could otherwise be withstood. Over time and space, subsequent population declines have threatened the genetic representation of each species because many populations have become disconnected and isolated from neighboring populations. Expanding distances between extant populations coupled with increasing populations of harmful nonnative species prevents normal colonizing mechanisms that would otherwise reestablish populations where they have become extirpated. This subsequently leads to a reduction in species redundancy when isolated, small populations are at increased vulnerability to the effects of stochastic events, without a means for natural recolonization. Ultimately, the effect of scattered, small, and disjunct populations, without the means to naturally recolonize, is weakened species resiliency as a whole, which ultimately enhances the risk of either or both species becoming endangered.

Stressor: Fisheries management
Exposure:
Response:
Consequence:
Narrative: Fisheries management activities can have significant negative effects on resident gartersnake populations when gartersnakes are not considered in project planning and implementation. While the continued use of rotenone and other fisheries management techniques in the conservation and recovery of native fish is supported, the potential and significant threat rotenone use may pose to these gartersnakes if their habitat is left with a fish community that is dangerously depleted or entirely removed for extended periods of time.

Stressor: Historic and current human-caused loss and degradation of habitat
Exposure:
Response:
Consequence:
Narrative: The period from 1850 to 1940 marked the greatest loss and degradation of riparian and aquatic communities in Arizona, many of which were caused by anthropogenic (human-caused) land uses and the primary and secondary effects of those uses (Stromberg et al. 1996, p. 114; Webb and Leake 2005, pp. 305–310). An estimated one-third of Arizona's pre-settlement wetlands has dried or been rendered ecologically dysfunctional (Yuhas 1996, entire).

Stressor: Altering or dewatering aquatic habitat
Exposure:
Response:
Consequence:
Narrative: Of all the activities that may threaten their physical habitat, none are more serious than those that reduce flows or dewater habitat, such as dams, diversions, flood-control projects, and groundwater pumping. Such activities are widespread in Arizona. For example, municipal water use in central Arizona increased by 39 percent from 1998 to 2006 (American Rivers 2006), and at least 35 percent of Arizona's perennial rivers have been dewatered, assisted by approximately 95 dams that are in operation in Arizona today (Turner and List 2007, pp. 3, 9). Larger dams may prevent movement of fish between populations (which affects prey availability for narrow-headed gartersnakes) and dramatically alter the flow regime of streams through the impoundment of water (Ligon et al. 1995, pp. 184–189). These diversions also require periodic maintenance and reconstruction, resulting in potential habitat damages and inputs of sediment into the active stream. In addition to affecting the natural behavior of streams and rivers through changes in timing, intensity, and duration of flood events, dams create reservoirs that alter resident fish communities. Water level fluctuation can affect the degree of benefit to harmful nonnative fish species. Reservoirs that experience limited or slow fluctuations in water levels are especially beneficial to harmful nonnative species whereas reservoirs that experience greater fluctuations in water levels provide less benefit for harmful nonnative species. The timing of fluctuating water levels contributes to their effect; a precipitous drop in water levels during harmful nonnative fish reproduction is most deleterious to their recruitment. A drop in water levels outside of the reproductive season of harmful nonnative species has less effect on overall population dynamics.

Stressor: Climate change and drought
Exposure:
Response:
Consequence:
Narrative: The narrow-headed gartersnake is the most aquatic of the southwestern gartersnakes and is a specialized predator on native and nonnative, softrayed fish found primarily in clear, rocky, higher elevation streams. Because of their aquatic nature, Wood et al. (2011, p. 3) predict they may be uniquely susceptible to environmental change, especially factors associated with climate change. Together, these factors are likely to make narrow-headed gartersnakes vulnerable to effects of climate change and drought, including reductions of suitable aquatic habitat, prey species, and the potential increase in harmful nonnative species.

Stressor: High-intensity wildfires and sedimentation of aquatic habitat
Exposure:
Response:
Consequence:
Narrative: Existing wildfire suppression policies intended to protect the expanding number of human structures on forested public lands have altered the fuel loads in these ecosystems and increased the probability of high-intensity wildfires. The effects of these high-intensity wildfires include the removal of vegetation, the degradation of subbasin condition, altered stream behavior, and increased sedimentation of streams. These effects can harm fish communities, as observed in the 1990 Dude Fire, when corresponding ash flows resulted in fish kills in Dude Creek

and the East Verde River (Voeltz 2002, p. 77). Fish kills can drastically affect the suitability of habitat for narrow-headed gartersnakes due to the removal of a portion or the entire prey base.

Recovery

Recovery Actions:

- Not developed.

References

USFWS 2013. Endangered and threatened wildlife and plants

threatened status for the northern Mexican gartersnake and narrow-headed gartersnake. Proposed Rule. Federal Register 78(132):41500-41547.

USFWS. 2021. Final Rule. FR Vol. 86, No. 201. Pages 58474-58523. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for the Narrow-Headed Gartersnake.

USFWS. 2013. Endangered and threatened wildlife and plants

SPECIES ACCOUNT: *Thamnophis sirtalis tetrataenia* (San Francisco garter snake)

Species Taxonomic and Listing Information

Commonly-used Acronym: SFGS

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

Physical Description

The genus Thamophis (family Colubridae) includes the slender serpents commonly known as garter snakes. The San Francisco garter snake (Thamnophis sirtalis tetrataenia; SFGS) has a wide dorsal stripe of greenish-yellow edged with black, bordered on each side by a broad red stripe which may be broken or divided, followed by a black stripe. The belly is greenish-blue in color and the top of the head is red to orange. The eyes are relatively large, and usually seven upper and ten lower labial scales are present. The body scales are in 19 rows and the dorsal scales are weakly to strongly keeled. Young range from 12.5 to 20 centimeters (cm) (5 to 8 inches [in.]) at birth (Stanford University 2013) and grow to a maximum length of 130 cm (51 in.) in adulthood (USFWS 1985), but most individuals are generally less than 91 cm (36 in.) (Stanford University 2013).

Taxonomy

The San Francisco garter snake is one of eleven recognized subspecies of the common garter snake (Thamnophis sirtalis) (USFWS 1985). Although most garter snakes have a conspicuous pale yellow or orange vertebral stripe and a pale stripe low on each side, the San Francisco garter snake can be distinguished by its wide greenish-yellow dorsal stripe bordered by a broad red stripe (USFWS 1985). Individuals in the West Bayshore population have a less distinctive, more "muddied" coloration, which could either indicate a loss of genetic diversity in the population or a broader expression of the species' natural phenotype (USFWS 2006). Some San Francisco garter snakes exhibit color patterns similar to that of a neighboring species, the California red-sided garter snake (T. s. infernalis) (USFWS 1985). In T. s. infernalis, the lower black stripe is absent and a series of regularly spaced black blotches are contiguous with the upper black stripe (USFWS 1985). There is an intergrade zone between the San Francisco garter snake and the red-sided garter snake that occurs on the San Francisco Peninsula and consists of at least six populations (Stanford University 2013; USFWS 2006). The intergrade zone extends approximately 19 kilometers (km) (12 miles [mi.]) on the eastern flank of the Santa Cruz Mountains from the vicinity of Boronda Lake in Palo Alto to Upper Crystal Springs Reservoir (Stanford University 2013).

Historical Range

The San Francisco garter snake is endemic to the San Francisco Peninsula and is known only from San Mateo County, California. Historically, San Francisco garter snakes were found on the San Francisco Peninsula from approximately the San Francisco County line, south along the eastern and western bases of the Santa Cruz Mountains at least to the Upper Crystal Springs Reservoir, and along the coast south to Año Nuevo Point, San Mateo County, California (USFWS 1985; USFWS 2006).

Current Range

Current range is assumed to be equivalent to historic range. Recent surveys suggest that there has likely been very little decrease in the overall range of the San Francisco garter snake compared to its historic distribution; however, they have likely been extirpated from individual localities within what is considered to be the historic range/distribution (USFWS 2006).

Distinct Population Segments Defined

No

Critical Habitat Designated

No;

Life History

Feeding Narrative

Adult: San Francisco garter snakes are opportunistic carnivores that primarily feed on ranid frogs, including Pacific tree frogs (Pseudacris regilla) and California red-legged frogs (Rana draytonii) (USFWS 2006). Immature California newts (Taricha torosa), recently metamorphosed western toads (Anaxyrus boreas), bullfrogs, (Rana catesbeiana), threespine stickleback (Gasterosteus aculeatus), and mosquitofish (Gambusia affinis) have also been recorded in the diets of San Francisco garter snakes (USFWS 1985). Individuals on the Stanford University property have been documented to feed on invertebrates and possibly small rodents and birds in addition to amphibians and fish (Stanford University 2013). During the spring and early summer, feeding occurs near or in ephemeral ponds inhabited by Pacific tree frogs, the primary food source for San Francisco garter snakes during this time. Although juvenile San Francisco garter snakes may initially capture and consume Pacific tree frog metamorphs (tadpoles that have recently gained adult frog features) in upland habitat, they have principally been observed moving back to aquatic sites to feed on the young-of-year frogs once these wetter areas begin to dry up and the tree frogs begin to disperse. Mature individuals prey on Pacific tree frogs as well, although they also eat California red-legged frogs during the late summer months. The late emergence of California red-legged frogs allows for a necessary second cycle of feeding by adult San Francisco garter snakes after the Pacific tree frogs have retreated from the drying wetlands to upland aestivation areas (USFWS 2006). Young are born ranging from 13 to 20 cm (5 to 8 in.) in length, and adults can reach a maximum of 130 cm (51 in.) (Stanford University 2013).Prey items are usually captured in wetlands, either in emergent vegetation or in areas of shallow open water (Stanford University 2013; USFWS 2006). Bullfrogs, largemouth bass, and sunfish compete with San Francisco garter snakes for California red-legged frog and Pacific tree frog tadpoles (USFWS 2006).

Reproduction Narrative

Adult: San Francisco garter snakes mate in the spring or fall, and mating is concentrated in the first few warm days of March. Males actively search for females, which are presumably found by scent. Many males may simultaneously court a single female. The augmented frequency in spring mating is thought to be due to the increased likelihood of encountering a mate as individuals emerge from hibernacula and concentrate near aquatic hunting grounds. Mating occurs on open grassy slopes, typically in the morning. Ovulation generally occurs in late spring, pregnancy in early summer, and live birth of young sometime in July or August. Like many members of the genus Thamnophis, females can store sperm throughout the winter. Mating aggregations of San Francisco garter snake have been observed in late October and early November (USFWS 1985). Females are ovoviviparous (internal fertilization and young are born live, but no placental connection) and typically bear young in secluded areas, either hidden in dense vegetation or under some type of cover (Stanford University 2013).Litter sizes range from 3 to 85 young and average between 12 to 24 young (USFWS 1985), which are 12.5 to 20 cm (5 to 8 in.) in length at birth (Stanford University 2013). The lifespan of San Francisco garter snakes is unknown, but likely does not exceed 10 years (Stanford University 2013). The sex ratio of San Francisco garter snakes is also unknown, but in other garter snakes (T. sirtalis) subspecies, males outnumber females (USFWS 2006).

Geographic or Habitat Restraints or Barriers

Adult: Lack of habitat connectivity, potentially highways and wide roads (USFWS 2006).

Spatial Arrangements of the Population

Adult: Clumped

Environmental Specificity

Adult: Narrow/specialist.

Site Fidelity

Adult: Moderate

Dependency on Other Individuals or Species for Habitat

Adult: Shallow water near shore is essential from May to July to ensure the successful hatching and metamorphosis of amphibian prey items, particularly Pacific tree frogs and California red-legged frogs (USFWS 2006). San Francisco garter snakes may depend on ground-burrowing rodents to create burrows, which snakes occupy during winter months (USFWS 2006).

Habitat Narrative

Adult: San Francisco garter snakes are habitat specialists with several strict habitat requirements. Necessary habitat for San Francisco garter snakes includes densely vegetated standing freshwater habitats with some open water areas, open grassy uplands and shallow marshlands for breeding, and rodent burrows for hibernacula (shelters where they spend dormant winter months) and refugia (USFWS 2006). San Francisco garter snakes occur in the vicinity of standing water—chiefly ponds, lakes, marshes, and sloughs (USFWS 1985). However, temporary ponds and other seasonal water bodies are also used. Emergent and bankside vegetation such as cattails (Typha sp.), bulrushes (Scirpus sp.), spike rushes (Juncus sp.), and water plantain (Alisma sp.) apparently are preferred and used for cover (USFWS 1985; USFWS 2006). The interface between stream and pond habitats is used for basking, while nearby dense vegetation or water often provides escape cover. If floating algal mats or rush mats are available, snakes will use these, because they are apparently more secure basking sites (USFWS 1985). Shallow water near shore is essential from May to July to ensure the successful hatching and metamorphosis of amphibian prey items, particularly Pacific tree frogs and California red-legged frogs (USFWS 2006).San Francisco garter snakes also require open grassy uplands and shallow marshlands with adequate emergent vegetation for breeding (USFWS 2006). Flora composition in the upland habitat sites includes, but is not limited to, coyote bush (Bacharis pillularis), wild oat (Avena fatua), wild barley (Hordeum sp.), and various brome species (Bromus sp.). San Francisco garter snakes may prefer an "early successional" grassland/shrub matrix with brush densities ranging from one average-sized bush per 30 m2 (323 sq. ft.) to one large bush per 20 m2 (215 sq. ft.) . By maintaining these ratios, there is sufficient cover from predators, while allowing for exposed surfaces to facilitate thermoregulation. The San Francisco garter snake also depends on ground-burrowing rodents to create burrows for snakes to use as hibernacula and refugia during the winter (USFWS 2006). The connectivity between aquatic and upland habitat is important and is currently threatened by development and infrastructure, including roads and highways (USFWS 2006).

Dispersal/Migration

Motility/Mobility

Adult: Moderate

Migratory vs Non-migratory vs Seasonal Movements

Adult: Nonmigratory

Dispersal

Adult: Moderate; may disperse to new areas in pursuit of prey (USFWS 2006).

Immigration/Emigration

Adult: Immigrates/emigrates.

Dependency on Other Individuals or Species for Dispersal

Adult: No

Dispersal/Migration Narrative

Adult: San Francisco garter snakes are nonmigratory, but move between pond foraging habitats and upland wintering sites seasonally. Peak activity occurs between March and July, which may correspond with dispersal patterns of their prey. Radio tracking studies indicate that most individuals remain within 100 to 200 m (328 to 656 ft.) of pond foraging habitats and wintering upland sites. San Francisco garter snakes do not appear to move distances greater than 1 km (0.6 mi.), but they may disperse to new areas in pursuit of prey. Roads and highways may adversely affect dispersal and movement of the San Francisco garter snakes (USFWS 2006).

Additional Life History Information

Adult: Peak activity occurs between March and July, which may correspond with dispersal patterns of their prey. Radio tracking studies indicate that most individuals remain within 100 to 200 meters (m) (328 to 656 feet [ft.]) of pond foraging habitats and wintering upland sites. San Francisco garter snakes do not appear to move distances greater than 1 km (0.6 mi.) (USFWS 2006).

Population Information and Trends

Population Trends:

Varied: three of the six known populations appear to be declining, one is likely stable or increasing, and two are unknown (USFWS 2006).

Species Trends:

Short-term decline of 10 to 30 percent (NatureServe 2015).

Number of Populations:

Six: West of Bayshore, Laguna Salada, San Francisco State Fish and Game Refuge, Pescadero Marsh, Año Nuevo State Reserve, and Cascade Ranch (USFWS 2006).

Population Size:

Unknown (USFWS 2006)

Resistance to Disease:

Low

Additional Population-level Information:

In the absence of reliable data regarding trends in the number of individuals in any given population, trends are often inferred from changes in habitat quality and quantity (USFWS 2006).

Population Narrative:

There are six known populations of San Francisco garter snake: West of Bayshore, Laguna Salada, San Francisco State Fish and Game Refuge, Pescadero Marsh, Año Nuevo State Reserve, and Cascade Ranch. Little data exist regarding population trends, demographic features, and demographic trends for San Francisco garter snake. In the absence of reliable data regarding trends in the number of individuals in any given population, trends have been inferred from changes in habitat quality and quantity (USFWS 2006). The West of Bayshore population, near the San Francisco International Airport, appears to have declined between 1983 and the mid-1990s, possibly due to drought (USFWS 2006). The Laguna Salada population is declining due to saltwater intrusion, and the Pescadero Marsh population is likely declining due to saltwater intrusion (USFWS 2006). The population statuses are unknown for the San Francisco Fish and Game Refuge and Cascade Ranch populations (USFWS 2006). The population at Año Nuevo State Reserve is likely stable or increasing (USFWS 2006). Overall, the species has experienced a short-term decline of 10 to 30 percent (NatureServe 2015).

Threats and Stressors

Stressor: Habitat loss and degradation
Exposure: Commercial and residential development, habitat management practices, hydrological changes, and agriculture activities.
Response: Degradation and loss of habitat, decreased ability to disperse/move, increase in predator abundance, and vehicle strikes.
Consequence: Decline in abundance due to lack of habitat; mortality.
Narrative: Habitat loss and degradation of remaining habitat are the primary threats to the recovery of San Francisco garter snake. The degradation of habitat is primarily due to fragmentation resulting from expansion of infrastructure to support increasing residential and commercial developments, including new roads, improved utilities matrices, and recreational facilities. Secondarily, habitat is degraded by management practices conflicting with the needs of the San Francisco garter snake, including the allowance of serial succession, the increased use of perch ponds (shallow artificial water impoundments often used in San Mateo for irrigation) with decreasing use of stock ponds, the dredging of waterways, and recreational use of off-highway

vehicles. Finally, fluctuations in water levels at reservoirs, flood control and channelization, and saline inundation events can result in further habitat degradation (USFWS 2006).

Stressor: Illegal collection
Exposure: Unauthorized take.
Response:
Consequence: Direct loss of individuals.
Narrative: The amount of illegal collection of the San Francisco garter snake and its effects on the species is not clear. The San Francisco garter snake has been illegally collected by amateur herpetologists, and some amount of illegal collection likely still occurs. It is unclear what the impact of unauthorized take is on wild San Francisco garter snake populations, or what can be done to reduce this impact (USFWS 2006).

Stressor: Chytrid fungus
Exposure: Chytrid fungus outbreaks.
Response: Reduction in prey availability.
Consequence: Decline in abundance due to lack of prey.
Narrative: The epidemic of chytrid fungus (Batrachochytrium dendrobatidis), a potentially deadly parasite, poses a threat to most of the San Francisco garter snake's natural prey base. Outbreaks of chytrid fungus are increasing in size and severity throughout the world, perhaps due to recent climate changes that have resulted from abnormal weather patterns. Because of the rapid pace at which chytrid fungus can spread, a lethal outbreak on the Peninsula could be capable of extirpating entire cohorts of amphibians. In the absence of an adequate food source, such an event could lead to catastrophic declines in all garter snake populations range-wide (USFWS 2006).

Stressor: Predation
Exposure: Presence of native and nonnative predators.
Response: Increased predation.
Consequence: Decline in abundance.
Narrative: Probable San Francisco garter snake predators include bullfrog (Rana catesbeieana), American crow (Corvus brachyrhynchos), red-tailed hawk (Buteo jamaicensis), red-shouldered hawk (Buteo lineatus), great egret (Ardea alba), snowy egret (Egretta thula), black crowned night heron (Nycticorax nycticorax), northern harrier (Circus cyaneus), great blue heron (Ardea herodias), long tailed weasels (Mustela frenata), and largemouth bass. In all cases, the extent that these predators influence San Francisco garter snake populations is not known (USFWS 2006).

Stressor: Mosquitofish
Exposure: High densities of mosquitofish.
Response: Decline in California red-legged frog tadpoles.
Consequence: Decline in prey abundance for San Francisco garter snakes.
Narrative: Introduced high densities of mosquitofish have been observed attacking California red-legged frog tadpoles. The stress produced from these attacks was shown to slow develop of the tadpoles, limiting the viability of individuals. With a reduction in the population of California red-legged frogs at a location with mosquitofish, San Francisco garter snakes could experience a similar decline in numbers (USFWS 2006).

Stressor: Parasites
Exposure: Presence of parasites.
Response:
Consequence: Direct mortality.
Narrative: Parasites may have been responsible for several mortalities of juvenile San Francisco garter snakes captured at the West of Bayshore location. Parasitic species encountered include a tapeworm, several flagellate protists, and eight different occurrences of nematode worms. Mosquitofish throughout the northern San Francisco Bay Area may serve as hosts for parasitic tapeworms and thorny-headed worms. These parasites could possibly be transmitted to animals that prey on mosquitofish, which include various ranid species and potentially San Francisco garter snakes (USFWS 2006).

Stressor: Fire suppression
Exposure: Fire suppression.
Response: Shift toward seral ecosystems.
Consequence: Reduction in habitat.
Narrative: One of the greatest threats to the San Francisco garter snake is the reduction of habitat quality resulting from the elimination of disturbance events throughout the Peninsula. Primarily, this is based on changes in management that encourage seral ecosystems. Dynamic grass-dominated uplands provide for, and are potentially maintained by, burrowing rodents that create tunnel systems used by San Francisco garter snakes for hibernacula during the winter months. The loss in recent years of ecological disturbance throughout the majority of San Mateo County has made it possibly for brush species to dominate former grasslands, potentially precluding burrowing animals. Fire suppression has allowed for the domination of these woody species across the coastal landscape, limiting the extent of grasslands that were likely important movement corridors between aquatic habitats. Augmented production levels of cattails also contribute to the loss of open water in aquatic systems. Additionally, the loss of traditional grazing practices on public lands has allowed for the accumulation of dense brush-dominated canopies across the remaining grasslands, which may decrease habitat suitability for the San Francisco garter snake. Reintroducing domestic grazing to grasslands could improve and restore habitat conditions for the San Francisco garter snakes (USFWS 2006).The perpetuation of seral conditions also has negatively impacted suitable aquatic habitat. Cattails (Typha sp.) and other emergent aquatic vegetation species may increase siltation rates in freshwater marshes due to the high water demands of these species, as well as their ability to trap overland runoff. The augmented production level of cattails contributes to the loss of the open-water component in aquatic systems. Open water, combined with emergent vegetation, creates a matrix of habitat elements thought to be necessary for Pacific tree frog and California red-legged frog populations—which are crucial for San Francisco garter snake aquatic habitat—already threated by salinization events—and the presence of bullfrogs (USFWS 2006.)

Stressor: Invasive species
Exposure: Presence of invasive species.
Response: Competition and predation.
Consequence: Direct mortality and reduction in prey availability.
Narrative: Increased presence of invasive species can compete for resources with the San Francisco garter snake or hunt individual San Francisco garter snakes directly. Bullfrogs, largemouth bass (Micropterus salmoides), and sunfish (Centrarchidae) consume California red-legged frog and Pacific tree frog tadpoles, and bullfrogs may prey directly on San Francisco garter

snakes (USFWS 2006).

Stressor: Habitat degradation due to artificial water impoundments
Exposure: Steep banks, earthen dams, and artificial water impoundments.
Response: Fewer basking opportunities, and lack of vegetation.
Consequence: Reduction in habitat.
Narrative: Steep banks and earthen dams associated with artificial water impoundment reduce the suitability of an area for San Francisco garter snakes. High grade slopes may reduce basking opportunities because of the absence of level areas in close proximity to dense vegetation. Reservoirs are often absent of adequate vegetation, exposing both the snake and its prey to additional predators (USFWS 2006).

Stressor: Roads
Exposure: Presence of roads and highways.
Response: Increase in vehicular strikes, reduction in dispersal.
Consequence: Direct mortality and decreased dispersal.
Narrative: Roads and highways may adversely affect dispersal and movement of San Francisco garter snakes. Reptiles often use roads for thermoregulation, which can lead to mortality due to vehicular strikes. Highways may also adversely affect dispersal and movement of amphibian prey species (USFWS 2006).

Recovery

Reclassification Criteria:
A primary objective of the 1985 Recovery Plan is to protect and maintain a minimum of six San Francisco garter snake populations, each containing 200 adult snakes (1:1 sex ratio). If this goal is obtained and maintained for 5 consecutive years for six of the ten populations, consideration for threatened status would be appropriate. The six significant populations include the West of Bayshore property (San Francisco International Airport), San Francisco State Fish and Game Refuge property (San Francisco Public Utilities Commission), Laguna Salada/Mori Point property (City of San Francisco/National Park Service), Pescadero Marsh and Año Nuevo State Reserve properties (California State Parks), and Cascade Ranch property (private land owner) (USFWS 1985; USFWS 2006).

Delisting Criteria:
Protect and maintain a minimum of ten San Francisco garter snake populations with approximately 200 adults (1:1 sex ratio) at each site within the snake's historic range for 15 consecutive years; delisting can then be considered. The recovery criteria include the six significant populations and the creation of four populations at undefined sites (USFWS 1985; USFWS 2006).

The recovery plan proposed that conservation agreements be signed with each of the land owners controlling the lands containing the six significant populations identified in the plan. However, no agreements have been completed to date and the additional four populations proposed in the recovery plan have not been identified. Additionally, although the precise population ratios of San Francisco garter snakes are unknown, studies of the eastern garter snake (Thamnophis sirtalis sirtalis) and the red-sided garter snake (T.s. infernalis) indicate that those sub-species do not exhibit 1:1 sex ratios, with males outnumbering females in the wild. If the sex ratios of San Francisco garter snakes are similar to the eastern and red-sided garter snakes, then a sex ratio of 1:1 may not be the appropriate criterion (USFWS 2006). In response to the issues described above, an updated recovery outline was prepared by the U.S. Fish and Wildlife Service (USFWS) in July 1995. In 2004, the Sacramento Fish and Wildlife Office established a San Francisco garter snake working group comprising USFWS employees familiar with current issues facing the species. The group's purpose is to design and implement specific conservation actions that could be performed prior to, and concurrent with, updating the recovery plan. The group is preparing an interim recovery implementation document consistent with the 1995 recovery outline to assist in guiding recovery actions until a revised recovery plan can be developed (USFWS 2006).

Recovery Actions:

- Use legal authorities to protect San Francisco garter snake and its habitat by enforcing laws and regulations to promote the conservation of the San Francisco garter snake and its habitat, evaluating success of law enforcement, and proposing appropriate new regulations or revisions (USFWS 1985).
- Protect the six known San Francisco garter snake colonies through appropriate management. These colonies include Pescadero Marsh Natural Preserve, Año Nuevo State Reserve, San Francisco State Fish and Game Refuge, the San Francisco Airport Millbrae site, and at least four additional populations (USFWS 1985).
- Assess population trends and make modifications in management plans if necessary. This includes developing population estimation techniques and conducting population surveys as necessary at Pescadero Marsh Natural Preserve, Año Nuevo State Reserve, San Francisco State Fish and Game Refuge, the Millbrae/Airport site, the Laguna Salada site, Cascade Ranch, and any additional sites discovered (USFWS 1985).
- Identify additional recovery needs for the San Francisco garter snake and modify prime objective/management plans accordingly. This includes obtaining life history data necessary to manage and eventually delist the San Francisco garter snake, determining habitat relationships, reevaluating introgression between the red-sided garter snake and the San Francisco garter snake, and identifying essential habitat (USFWS 1985).
- Provide for public information and awareness by providing onsite interpretive programs on public lands, preparing a small brochure on the San Francisco garter snake and the recovery program, and developing a slide-tape program for public presentations (USFWS 1985).
- Develop an updated recovery plan and an expanded San Francisco garter snake working group (USFWS 2006).
- Encourage conservation among private landowners (USFWS 2006).
- Continue ongoing habitat restoration and enhancement for wild populations (USFWS 2006).
- Complete captive holding facilities for use in head starting programs, in the restoration of worldwide zoo populations, and as temporary lodging during habitat maintenance (USFWS 2006).
- Increase research of population trends, demography, and phylogenetics (USFWS 2006).
- Increase law enforcement at vulnerable locations (USFWS 2006).
-

Conservation Measures and Best Management Practices:

- Permittee-responsible mitigation, also sometimes referred to as turn-key mitigation, includes activities or projects undertaken by a permittee (or authorized agent) to provide compensatory mitigation to offset impacts from a single project. The permittee retains full responsibility for this mitigation. Ideally, permittee-responsible mitigation projects are established in advance of the project-related impacts they are offsetting; however, this typically does not occur due to multiple factors. Habitat compensation through permittee-responsible mitigation for the San Francisco gartersnake has occurred throughout the subspecies range for a number of projects. For example, there have been a number of restoration actions implemented by the San Francisco Public Utilities Commission in the Crystal Springs Reservoir watershed as mitigation for the effects of the Lower Crystal Springs Dam Improvement Project and other Water Storage Investment Program (WSIP) projects. Additionally, mitigation for PG&E projects has resulted in aquatic and upland habitat enhancement and preservation near the WOB and Pescadero population complexes (various Service biological opinions; Terry in litt. 2020) (USFWS, 2020)

- RECOMMENDATIONS FOR FUTURE ACTIONS • Continue demographic and genetic monitoring of the species: Continued trapping surveys for populations with estimated abundance and genetic diversity will assist with assessing status and trends for the species. • Encourage conservation among private landowners: Conservation by private landowners should be encouraged. In addition to including public entities in conservation and recovery efforts, participation by private land owners from both agricultural and urban settings is needed to recover the San Francisco gartersnake. This is especially important in locations where substantial quantities of suitable habitat persist. In order to accomplish this, ongoing efforts to conduct outreach meetings to educate the public as to the needs of the species should be fully supported by the Service and its partners. The Service and partners can explore the possibility of working with private and non-federal property owners to develop Safe Harbor Agreements (SHAs), voluntary agreements which contribute to the recovery of species listed as endangered or threatened under the ESA • Conduct habitat assessments and surveys for population complexes with unknown conditions or in suitable habitat without known populations: Recent trapping surveys of known San Francisco gartersnake populations have been conducted as part of an effort to identify potential donor sources for a headstarting program focused on known populations with high quality habitat, many (but not all) of them on public lands. Habitat assessments and trapping surveys in the central part of the species range where conditions are largely unknown is necessary to evaluate the current and future condition of the species in those areas. Surveys on private lands, with landowner support, can help encourage private landowners to participate in conservation and recovery efforts. • Establish a San Francisco gartersnake working group or recovery implementation team. The group would serve to coordinate and facilitate headstarting efforts and prioritize other recovery actions and implementation. By conducting organized discussions with relevant parties, coordination in conservation efforts will be increased. • Continue efforts towards headstarting San Francisco gartersnakes: Identify source and donor recipient populations, determine recommended protocols for headstarting (and/or captive breeding, rearing, etc.) and measuring success, complete a genetic management plan for translocations and introductions/reintroductions, and conduct restoration for donor populations as appropriate. • Focus on habitat restoration to restore connectivity within and between populations: Reinstating connectivity can increase genetic diversity and enhance representation for the species. (USFWS, 2020a)

Additional Threshold Information:

-
-

References

32 FR 4001. Native Fish and Wildlife, Endangered Species. Final Rule. Vol. 32, No. 48. Federal Register 4001. March 11, 1967. Rules and Regulations. Available online at: http://ecos.fws.gov/docs/federal_register/fr18.pdf

Stanford University. 2013. Habitat Conservation Plan. Section 2, Physical/Biological Setting, Including Covered Species. Revised March 2013. Available online at: http://hcp.stanford.edu/2013HCP/HCP%20March%202013/Stanford%20HCP%20Ch%20%202%20without%20SF-LT%20basin%20(March%202013).pdf

USFWS (U.S. Fish and Wildlife Service). 1985. Recovery Plan for the San Francisco Garter Snake (Thamnophis sirtalis tetrataenia). U.S. Fish and Wildlife Service, Portland Oregon. September 11. 77 pp. Available online at: https://ecos.fws.gov/docs/recovery_plan/850911.pdf

USFWS (U.S. Fish and Wildlife Service). 2006. San Francisco Garter Snake (Thamnophis sirtalis tetrataenia) 5-Year Review, Summary and Evaluation. U.S. Fish and Wildlife Service, Sacramento Field Office, Sacramento, California. September 26. 42 pp. Available online at: https://ecos.fws.gov/docs/five_year_review/doc774.pdf.

NatureServe. 2015. NatureServe Explorer, An online encyclopedia of life [web application]. Available online at: http://explorer.natureserve.org/. Date accessed: February 17, 2016

USFWS. (U.S. Fish and Wildlife Service). 2006. San Francisco Garter Snake (Thamnophis sirtalis tetrataenia) 5-Year Review, Summary and Evaluation. U.S. Fish and Wildlife Service, Sacramento Field Office, Sacramento, California. September 26. 42 pp. Available online at: https://ecos.fws.gov/docs/five_year_review/doc774.pdf.

USFWS. 2020. Species Status Assessment for the San Francisco gartersnake (Thamnophis sirtalis tetrataenia), Version 1.0. May 2020. Sacramento, California.

USFWS. 2020a. 5-YEAR REVIEW San Francisco gartersnake (Thamnophis sirtalis tetrataenia). 5 pp.

SPECIES ACCOUNT: *Uma inornata* (Coachella Valley fringe-toed lizard)

Species Taxonomic and Listing Information

Commonly-used Acronym: CVFTL

Listing Status: Threatened; September 25, 1980 (45 FR 63812).

Physical Description

The Coachella Valley fringe-toed lizard (Uma inornata; CVFTL) is a medium-sized, highly specialized endemic lizard that inhabits windblown desert ecosystems of the Coachella Valley in Riverside County, California. This species averages 15 to 23 centimeters (cm) (6 to 9 inches [in.]) in total length, with the tail comprising between 49 to 64 percent of the total length of adult lizards. Coachella Valley fringe-toed lizard have a white or sandy-colored belly and back and light eye-like patterns that form shoulder stripes. Coachella Valley fringe-toed lizard have several specialized adaptations: elongated scales on their hind feet ("fringes") for added traction in loose sand, a shovel-shaped head and lower jaw adapted to aid diving into and moving short distances beneath the sand, elongated scales covering their ears to keep sand out, and unique morphology (form or structure) of internal nostrils that allows them to breathe below the sand without inhaling sand particles (45 FR 63812; USFWS 2010).

Taxonomy

The Coachella Valley fringe-toed lizard is closely related to the Colorado Desert fringe-toed lizard (Uma notata) and the Mojave fringe-toed lizard (Uma scoparia); however, the species can be separated by coloration and morphology. Dorsal color of the Coachella Valley fringe-toed lizard is whitish to pale gray, with a pattern of ocelli (eyelike markings) formed by dark markings on the pale background. The ocelli form a pattern of longitudinal strips over the shoulders. The ventral surface is white. One or several black dots may be present on side of the abdomen, and dusky lines are present on the throat. The Coachella Valley fringe-toed lizard usually has three internasal scales and fewer than 29 femoral pores. In contrast, the Colorado Desert fringe-toed lizard has a buffy dorsal ground color; a single large, black, ventrolateral blotch on each side of the abdomen; an orange color surrounding the black blotches on the ventrolateral surface; and generally bolder throat markings. The Mojave fringe-toed lizard has a buffy dorsal ground color, scattered dorsal ocelli, larger black ventrolateral blotches, an overall greenish-yellow ventral coloration, black gular crescents, usually five internasals, and usually more than 29 femoral pores (USFWS 1984).

Historical Range

At the time the species was listed in 1980, an estimated 255 square kilometers (km2) (98 square miles [sq. mi.]) of extant blowsand habitat was recorded. The Recovery Plan estimated that approximately (500 km2) (193 sq. mi.) of Coachella Valley fringe-toed lizard habitat existed in the Coachella Valley prior to human settlement of the area, and that approximately 328 km2 (126 sq. mi.) of “occupiable habitat” was extant as of 1984 (45 FR 63812; USFWS 1984).

Current Range

There are currently seven Coachella Valley fringe-toed lizard conservation areas throughout Coachella Valley: Snow Creek/Windy Point, White-Water Floodplain, Willow Hole, Edom Hill, Thousand Palms, East Indio Hills, and Santa Rosa and San Jacinto mountains. These conservation areas total 55 km2 (21 sq. mi.) of habitat. There are currently 59 known occurrences of Coachella Valley fringe-toed lizard in the Coachella Valley that are presumed extant, and another 18 extant occurrences of Coachella Valley fringe-toed lizard outside of conservation areas (USFWS 2010).

Distinct Population Segments Defined

No

Critical Habitat Designated

Yes; 9/25/1980.

Legal Description

On September 25, 1980, the U.S. Fish and Wildlife Service designated critical habitat for Uma inornata pursuant to the Endangered Species Act of 1973, as amended (45 FR 63812 - 63820).

Critical Habitat Designation

Critical habitat for the Coachella Valley fringe-toed lizard is desingated in Riverside County, California.

Primary Constituent Elements/Physical or Biological Features

Not available

Special Management Considerations or Protections

Three general types of blow-sand deposits occur in a mosaic pattern across the Coachella Valley: sandy plains, sand hummocks, and mesquite dunes. The Coachella Valley fringe-toed lizard is restricted to these habitats. Sand hummocks (small and deposits two to five feet high), which form on the leeward side of bushes, are the most common type of blow-sand deposits in the Coachella Valley comprising about 60 percent of the fringe-toed lizard habitat (England and Nelson 1976). Army Corps of Engineers proposals for flood control structures in the U.S. Whitewater River also would facilitate urban expansion in the valley. With or without these developments, however, agriculture and urbanization are continuing to eliminate more fringe-toed lizard habitat each year and there are no reasons to believe that these processes will stop until all private land is the Coachella Valley has been developed. The Service therefore believes that the physical and biological features of this habitat are such as to require special management considerations and protection.

Life History

Feeding Narrative

Adult: The Coachella Valley fringe-toed lizard is both opportunistic and omnivorous, feeding on several different plants and plant-dwelling arthropods. The species is diurnal; however, individuals are crepuscular for feeding (active at dusk and dawn). As is seen in many reptiles that live in arid environments, these lizards obtain most of their water from the insects and plants that they ingest. The species requires open blowsands with minimal vegetation cover for feeding.Surface activity of Coachella Valley fringe-toed lizard is limited by ambient temperatures. They are active when the air temperature 1 meter (m) (3.3 feet [ft.]) above ground surface is between 22 and 39 degrees Celsius (°C) (71.6 and 102.2 degrees Fahrenheit [°F]), and ground surface temperatures are between 37 and 58 °C (98.6 and 136.4 °F). The species is inactive and hibernates during the winter (NatureServe 2015; USFWS 2010; USFWS 1984).

Reproduction Narrative

Adult: Coachella Valley fringe-toed lizards reach sexual maturity when individuals reach 65 to 70 mm (2.5 to 2.75 in.) in snout-vent length, usually two summers after hatching. They are oviparous, and breed from spring (April/May) to summer (July/August), having one reproductive event with clutches of two to four eggs. After very wet winters they may lay more than one clutch, and in drought years they may not reproduce at all. Parental care is thought to be low, with Coachella Valley fringe-toed lizard leaving young to fend for themselves. Little is known about the location and timing of egg laying; however, hatchlings begin to appear from late June to early September and hibernate over winter, burrowing in November and emerging in February. More young are produced in years with a significant amount of rainfall (USFWS 1984; USFWS 2010).

Geographic or Habitat Restraints or Barriers

Adult: Low vegetation cover with low sand compaction; from sea level up to elevations of about 490 m (1,600 ft.) (USFWS 2010).

Spatial Arrangements of the Population

Adult: Clumped

Environmental Specificity

Adult: Narrow/specialist.

Tolerance Ranges/Thresholds

Adult: Low

Site Fidelity

Adult: Moderate

Habitat Narrative

Adult: Coachella Valley fringe-toed lizard is specialized to occupy a specific habitat type, consisting of accumulations of windblown (aeolian) sand from sea level up to elevations of about 490 m (1,600 ft.). Deeper sand deposits with more topographic relief are preferred by the species over flatter sand sheets. Low sand compaction is an important preferred habitat characteristic, because it is easier for Coachella Valley fringe-toed lizards to burrow in less compact sand. The presence of four-winged saltbush (Atriplex canescens), Russian thistle (Salsola tragus), and twinbugs (Dicoria) were confirmed as features in high use areas. These lizards prefer fine sand grains from 0.1 to 0.5 mm (0.004 to 0.02 in.) in size, and very low vegetation cover. There are four main sand transport systems that maintain the ecosystems on which this species depends. These systems are composed of sand source areas, fluvial transport zones, fluvial deposition/aeolian erosion areas, wind transport corridors, and aeolian sand deposition areas. Fine sand in Coachella Valley fringe-toed lizard habitat comes from windblown sand source areas (USFWS 2010).

Dispersal/Migration

Motility/Mobility

Adult: High

Migratory vs Non-migratory vs Seasonal Movements

Adult: Nonmigratory

Dispersal

Adult: Dispersal is unlikely in the absence of nearby areas of windblown sands. In areas of active sand transport, sand dunes are highly dynamic and continually moving; in some cases, moving several m (tens of ft.) per year. Movement between populations is poorly studied, although it is likely limited by the natural movement of sands (USFWS 1984).

Dispersal/Migration Narrative

Adult: Coachella Valley fringe-toed lizards are very mobile, but nonmigratory. The home range size of male Coachella Valley fringe-toed lizards (845 to 1,295 m2 [9,095 to 13,940 sq. ft.]) is approximately twice that of female Coachella Valley fringe-toed lizards (269 to 605 m2 [2,895 to 6,512 sq. ft.]). Deeper sand deposits with more topographic relief and low vegetation cover are needed for movement. Dispersal of fringe-toed lizards is unlikely in the absence of nearby areas of windblown sands. In areas of active sand transport, sand dunes are highly dynamic and continually moving; in some cases, moving several m per year. Movement between populations is poorly studied, although it is likely limited by the natural movement of sands (USFWS 2010)

Additional Life History Information

Adult: The home range size of male Coachella Valley fringe-toed lizards (845 to 1,295 square meters [m2] [9,095 to 13,940 square feet (sq. ft.)]) is approximately twice that of female Coachella Valley fringe-toed lizards (269 to 605 m2 [2,895 to 6,512 sq. ft.]) (USFWS 2010).

Population Information and Trends

Population Trends:

Short-term: stable; long-term: decline of 50 to 70 percent (NatureServe 2015).

Species Trends:

Short-term: stable; long-term: decline of 50 to 70 percent (NatureServe 2015).

Number of Populations:

135 presumed extant occurrences (USFWS< 2023)

Population Size:

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

Minimum Viable Population Size:

Unknown; further study is required (USFWS 2010).

Resistance to Disease:

Possibly low due to very homogeneous populations (USFWS 2010).

Adaptability:

Possibly low due to very homogeneous populations (USFWS 2010).

Additional Population-level Information:

There are currently 59 presumed extant occurrences in the Coachella Valley, with 41 occurring or partially occurring within the boundaries of six CVMSHCP conservation areas (USFWS 2010).

Population Narrative:

There are currently seven conservation areas for Coachella Valley fringe-toed lizard with species believed to be stable overall: Snow Creek/Windy Point, White-Water Floodplain, Willow Hole, Edom Hill, Thousand Palms, East Indio Hills, and Santa Rosa and San Jacinto mountains. Due to their cryptic nature, it is very difficult to accurately measure current populations; current estimates range from 2,500 to 100,000 individuals. The species' populations are currently viewed as stable; however, populations are thought to have declined from 50 to 70 percent since the 1980s and 1990s. There are currently 59 presumed extant occurrences in the Coachella Valley, with 41 occurring or partially occurring within the boundaries of six CVMSHCP conservation areas. Due to very homogenous populations, it is speculated that the species may have a low adaptability and disease resistance (NatureServe 2015; USFWS 2010). We reviewed each CVFTL occurrence in the California Natural Diversity Database (CNDDB 2022) (Appendix I). The CNDDB contains 162 CVFTL occurrences: 135 are presumed extant, 17 are possibly extirpated, and 10 are extirpated. CNDDB is a positive sighting database and occurrences are generally considered presumed extant unless documentation supports a change to “extirpated” or “possibly extirpated” (CNDDB 2020, p. 11). Aerial imagery can also support a status change (USFWS, 2023)

Threats and Stressors

Stressor: Urbanization
Exposure: Direct loss of habitat, fragmentation of habitat, and modification of habitat in the existing conservation areas.
Response: Habitat degradation and loss.
Consequence: Populations are fragmented and possibly extirpated.
Narrative: Impacts from urbanization resulted in direct loss of habitat, fragmentation of habitat, and modification of habitat in the existing conservation areas, all of which affect essential ecosystem processes outside the conservation areas. Ecological processes needed to generate blowsand habitat are affected by continued development throughout the Coachella Valley, through alteration of hydrological systems and through fencing and housing development that blocks winds that move sands along the ground. Since listing, 52 occurrences were extirpated by urban development. Development contributed to range-wide habitat loss, and fragmentation has resulted in the isolation of Coachella Valley fringe-toed lizard into several likely small remnant or peripheral populations (USFWS 2010).

Stressor: Nonnative invasive plants
Exposure: Invasive plants outcompeting native plants.
Response: Coachella Valley fringe-toed lizard will not occupy areas under a thick canopy; habitat degradation and loss.
Consequence: Additional research needed.
Narrative: Saharan mustard (Brassica tournefortii), has relatively recently covered large areas of Coachella Valley fringe-toed lizard habitat and sand source areas in high rainfall years. Coachella

Valley fringe-toed lizards will not occupy areas under a thick canopy, because the strong sunlight they require for thermoregulation cannot penetrate and the open spaces they prefer become compromised by thick vegetation. The portions of the Thousand Palms Conservation Area dunes where blowsands were most active (greater aeolian sand movement, less perennial vegetation) had substantially less Saharan mustard cover and were the areas where the highest densities of Coachella Valley fringe-toed lizards were predictably found. Saharan mustard dominated the habitat areas with less active blowsands, thereby restricting useable habitat for Coachella Valley fringe-toed lizards during the period of invasion/expansion. Saharan mustard may be a significant threat to Coachella Valley fringe-toed lizard and its ecosystem, though additional research is needed (USFWS 2010).

Stressor: Obstruction of sand transport systems
Exposure: Shrubs, topographic features, wind breaks, and fencing limiting movement of blow sand.
Response: Degradation and loss of habitat.
Consequence: Reduced population and possible population extirpation.
Narrative: Blowsands are moved by the wind close to the ground surface, compared to smaller particles (e.g., dust) which billow high in the air. One scientist observed that 50 percent of the sediment grains (by weight) in the Valley traveled on the wind within 13 cm (5 in.) of the ground, and 90 percent moved within 64 cm (25 in.) of the ground. Shrubs, topographic features, and structures slow the wind near the ground surface, causing sand to drop out and accumulate, and dunes and hummocks to form near these features. Sand accumulations increase and decrease over time, depending on the amount of entrained sand (in the aeolian transport supply from upwind) and wind speeds. When upwind sand supply is substantial, temporary accumulations of blowsand build up, creating dunes often lasting for years or decades. Without the supply of additional blowsand transported from areas upwind (similar to the dwindling of fluvial sediment deposits during extended droughts/periods without stormflows), wind erodes blowsands from these temporary aeolian accumulations faster than it is replaced. The result is depleted or eliminated dunes or hummocks, and thus degraded Coachella Valley fringe-toed lizard habitat. Areas without input of sand become “armored” (surface capped by larger materials) as the larger sediments that are not typically carried by the wind remain and the finer sands blow away. These areas of depleted blowsands (finer sand particles) do not provide suitable habitat for Coachella Valley fringe-toed lizards (USFWS 2010).

Stressor: Changes in hydrology
Exposure: Alterations in hydrology.
Response: Degradation and loss of dune habitat.
Consequence:
Narrative: At listing, hydrological changes were not identified as a threat concerning Coachella Valley fringe-toed lizard populations or its habitat. However, changes in hydrology, specifically due to groundwater pumping and creation of percolation ponds, have affected the habitat of Coachella Valley fringe-toed lizard and constitute new threats. Impacts from this threat are more likely to affect the following areas: Thousand Palms Conservation Area, Whitewater Floodplain Conservation Area, Willow Hole Conservation Area, and the Edom Hill Conservation Area. In the Thousand Palms Conservation Area, large areas of mesquite hummocks have disappeared that were clearly visible in historical photographs. Mesquite hummocks, present historically in the conservation area, likely played an important role in dune formation on the Thousand Palms Conservation Area. Groundwater well data for the region indicate that water levels have dropped

considerably in the aquifer under the conservation area over the last couple decades. Groundwater pumping of the aquifer has likely caused substantial drops in the groundwater level under the conservation area. Current groundwater levels are likely beyond the reach of mesquite, resulting in the potential loss of the mesquite stands that formerly helped the dunes/hummocks of the Thousand Palms Conservation Area. Because of the falling water table, mesquite hummocks may never be restored naturally to the conservation area, though recent revegetation efforts have demonstrated that mesquite can be established in the Sonoran Desert of California. The lack of mesquite would expedite the loss of blowsand and Coachella Valley fringe-toed lizard habitat from this conservation area (USFWS 2010).

Stressor: Off-highway vehicle (OHV) activity
Exposure: OHV activity.
Response: Loss and degradation of habitat, increased water and wind erosion, and increased soil compaction.
Consequence: Loss of individuals; additional research is needed to assess this threat.
Narrative: OHV activity has been shown to impact dune habitats by altering vegetation communities, increasing levels of water and wind erosion, and increasing soil compaction. Illegal OHV recreation regularly occurs on most of the remaining habitat areas for the species, primarily in the Whitewater Floodplain Conservation Area and surrounding areas, the Willow Hole Conservation Area, the Edom Hill Conservation Area, and the Snow Creek/Windy Point Conservation Area. The County of Riverside has recently increased enforcement related to OHV use; the Bureau of Land Management has fenced large portions of their lands with Coachella Valley fringe-toed lizard habitat, and will conduct inspections at least every 2 weeks to determine compliance/effectiveness and document OHV management measures. OHV use in Coachella Valley remains a current threat impacting Coachella Valley fringe-toed lizard habitat; additional research is needed to assess this threat (USFWS 2010).

Stressor: Regulatory mechanisms
Exposure: Inadequacy of existing regulatory mechanisms.
Response: Loss of habitat or habitat degradation.
Consequence: Reduction in population; extirpation.
Narrative: The state's authority to conserve rare wildlife and plants comprises three major statutes: the California Endangered Species Act, California Environmental Quality Act, and the Natural Community Conservation Planning Act. The species is also protected under the federal endangered species act, and under the FTLHCP. The CVMSHCP affords protection to 42 Coachella Valley fringe-toed lizard occurrences and the sand transport systems, through adaptive management of Coachella Valley fringe-toed lizard habitat. Protections afforded by the plan have helped to preserve Coachella Valley fringe-toed lizard habitat and minimize further impacts of habitat loss and fragmentation. Protection is also afforded to Coachella Valley fringe-toed lizard habitat by restricting use of nonnative plant species into landscapes on or adjacent to the conservation areas. Though impacts from development and other threats have been reduced, existing regulatory mechanisms remain inadequate to ameliorate impacts from current threats to Coachella Valley fringe-toed lizard and their habitat throughout their range (USFWS 2010).

Stressor: Small population size
Exposure: Small population size.
Response: Genetically bottlenecked populations typically experience substantially lowered reproductive fitness, and are more susceptible to extirpation.

Consequence: Population loss and extirpation, and decreased genetic variation.
Narrative: Coachella Valley fringe-toed lizard population sizes are unknown in conservation areas, though average census population numbers, based on variable density data and the amount of potential habitat, were estimated for the Whitewater Floodplain Conservation Area and Thousand Palms Conservation Area. Since 1985, studies revealed that this species is subject to large fluctuations in population size. A population that fluctuates widely is more likely to decline to a level from which it cannot recover than is a population that remains relatively stable. These fluctuations are a threat to the Coachella Valley fringe-toed lizard, due to extremely low numbers reached during declining fluctuation periods. Managing for specific population targets for Coachella Valley fringe-toed lizards may be inappropriate, because it is difficult to "distinguish natural population fluctuations from a downward trajectory of a species at risk of extinction." During extended droughts, Coachella Valley fringe-toed lizard population numbers were often near zero, but the populations quickly rebounded during periods of average rainfall, indicating that these extreme population dips were acceptable for considering these isolated populations viable. The degree of homogeneity in Coachella Valley fringe-toed lizards likely reflects a genetic bottleneck, and continued loss of gene variability is expected due to ongoing destruction and degradation of Coachella Valley fringe-toed lizard dune habitat. The loss of genetic variability in Coachella Valley fringe-toed lizards decreases the likelihood that genetic variations that would likely aid the species' persistence in the future remain in the population. The evolutionary potential (potential for a species to adapt to change over time) of a species is reduced by genetic drift and inbreeding in small populations. This makes a population more prone to extinction or extirpation from new diseases or other environmental changes (USFWS 2010).

Stressor: Climate change
Exposure: Global and regional changes in climate.
Response: Reduction and/or loss of habitat, change in behavior, changes in competition, nonnative species, low water supply, and disease.
Consequence: Reduction in population, and population extirpation.
Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate intense precipitation events, warmer air temperatures, and increased summer continental winds. Climate modeling for California indicates similar outcomes in temperature and precipitation. Results from a 2007 International Panel on Climate Change assessment indicated a 1 to 3 °C (1.8 to 5.4 °F) increase in average temperature by the year 2050. Over the same time span, a 12 to 35 percent decrease in precipitation is indicated. The Desert Research Institute of the Western Regional Climate Center (WRCC) documented in Palm Springs, in the northern portion of the Coachella Valley, a 2 °C (4 °F) increase in average temperature since 1950. Since 1950, the WRCC has shown a steady increase in temperatures throughout the Coachella Valley. A biological model, validated with observed extirpations of 12 local spiny (Sceloporus) lizard populations in Mexico, predicted the extinction of nearly 40 percent of all lizard species worldwide by 2080 due to global warming processes. These extinctions were correlated with the warming of sites in spring when reproductive energy demands are highest. As daily temperatures become greater, lizard species spend greater amounts of time burrowing or in refuges and less time foraging. Significant temperature increases create a stressor for endemic species, which may enhance pressures from competitors, nonnative species, habitat change, low water supply, and disease. Species must adapt to these pressures in situ (in place) or shift their geographic range. Such a shift in range for narrow endemic species such as Coachella Valley fringe-toed lizard could exceed the tolerance of the species. Additionally, very little available habitat in the Coachella Valley exists to assist this species with a range shift. Though we know little of the

adaptive ability of Coachella Valley fringe-toed lizard, climate change could potentially pose a significant range-wide threat to the species (USFWS 2010).

Recovery

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

Recovery Priority Number: 5C

Delisting Criteria:
The recovery plan indicates that the primary objective is to minimize further decline of Coachella Valley fringe-toed lizard and degradation of its habitat, by securing and protecting suitable habitat in two or more large-scale protected areas (one consisting of designated critical habitat) in historical habitats that maintain viable, self-sustaining populations, thus permitting consideration for delisting. The size of the areas to be preserved and the size of Coachella Valley fringe-toed lizard populations essential to recovery need to be determined (USFWS 1984; USFWS 2010). The 2010 5-Year Review identifies the recovery actions from the 1984 Recovery Plan as criteria to accomplish the objective, and recover/delist the species. The 5-Year Review identifies all of the recovery/delisting criteria or recovery actions as applicable; however, some of the criteria are not up to date, and one does not pertain to any threat factors (USFWS 2010).

To protect, manage, and enhance existing habitat for CVFTL in the Coachella Valley by determining appropriate method(s) to protect habitat; protect critical habitat; protect other areas as needed; monitor existing habitat conditions and distribution of habitat and modify management actions accordingly (habitat surveys); and develop and implement habitat management plan(s) for protected areas (restoration of habitat, evaluation of CVFTL success in restored habitat) (USFWS 2010).

Maintain and enhance CVFTL populations by determining biological requirements (population densities in various habitats, population dynamics, minimum sustainable population size, predator-prey and competitive relationships, key variables of high, medium, and low quality habitats) and utilizing results in management decisions; determine population status regularly (experimental design for sampling plots, establishment of permanent study plots, regular survey of selected plots) and utilize data in management decisions; develop and implement recommendations to maintain CVFTL genetic diversity; determining effects of human-related modifications on CVFTL populations (windbreaks, OHV use, pesticides, and nonnative invasive plants) and utilize data in management decisions; and implement programs to reestablish and evaluate CVFTL in rehabilitated areas under management control (probability of success, site selection, development of habitat management plans, restore sites for testing, reintroduction of CVFTL into restored areas as necessary, monitoring of CVFTL population numbers within restored areas).

Foster public awareness and support for the conservation of CVFTL and its ecosystem through an education and public awareness program by establishing an interpretive kiosk with self-guided nature trail at reserve sites; prepare periodic press releases on the ecology and status of CVFTL; prepare programs on CVFTL recovery and management and present to schools, clubs, and other organizations; developing and distributing posters on CVFTL for local businesses; and develop and distribute short films on conservation of CVFTL (USFWS 2010).

Utilize existing laws and regulations protecting CVFTL and its habitat by enforcing State and Federal laws; evaluating success of law enforcement; and proposing appropriate new regulations or revisions (USFWS 2010).

Recovery Actions:

- The recovery plan identifies a number of recovery actions needed to minimize the further decline of the Coachella Valley fringe-toed lizard and degradation of its habitat (USFWS 1984). The 2010 5-Year Review identifies the same recovery actions as criteria to accomplish the objective, and to recover/delist the species. The 5-Year Review identifies all of the recovery/delisting criteria or recovery actions as applicable; however, some of the criteria are not up to date, and one does not pertain to any threat factors (USFWS 2010).
- To protect, manage, and enhance existing habitat (USFWS 1984).
- Maintain and enhance Coachella Valley fringe-toed lizard populations (USFWS 1984).
- Foster public awareness and support for the conservation of Coachella Valley fringe-toed lizard and its ecosystem through an education and public awareness program (USFWS 1984).
- Use existing laws and regulations protecting Coachella Valley fringe-toed lizard and its habitat (USFWS 1984).
- Permanently protect Coachella Valley fringe-toed lizard dune habitat and the essential fluvial and aeolian ecological processes that sustain this habitat in the six conservation areas (Snow Creek/Windy Point Conservation Area, Whitewater Floodplain Conservation Area, Willow Hole Conservation Area, Edom Hill Conservation Area, Thousand Palms Conservation Area, and East Indio Hills Conservation Area) where presumed extant occurrences of Coachella Valley fringe-toed lizard currently exist. Acquire/protect from development the parcels of suitable habitat throughout Coachella Valley fringe-toed lizards range that occur in essential sand transport corridors (USFWS 2010).
- Through planting and irrigation, restore mesquite hummocks in the Willow Hole Conservation Area and Thousand Palms Conservation Area, thus allowing for the rejuvenation of Coachella Valley fringe-toed lizard dune habitat (USFWS 2010).
- Establish a minimum effective population size to ensure the genetic diversity of this species, and create additional research opportunities and modeling to determine the necessary habitat required to maintain genetic diversity (USFWS 2010).
- Conduct annual monitoring surveys for Coachella Valley fringe-toed lizard on each of the six conservation areas where presumed extant occurrences are located (USFWS 2010).
- Revise the recovery plan to include newly found threats (alterations in hydrology, climate change, and small population size) as they pertain to Coachella Valley fringe-toed lizard and its habitat (USFWS 2010).
-

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The recovery plan outlined recovery objectives for CVFTL. This includes having two or more large-scale protected areas that maintain viable self-sustaining populations (Service 1984, p. 7). The recovery plan focuses on protecting remaining habitat and avoiding future habitat loss, which has always been the primary threat to CVFTL. Based on our synthesis of new information in this 5-year review, recommendations for future actions are listed below. 1. Conduct surveys in CVFTL habitat to determine presence. a. Survey the East Indio Hills Conservation Area to determine whether CVFTL are extant or extirpated. b. Survey suitable habitat within the Santa Rosa and San Jacinto Mountains Conservation Area. 2. Continue to acquire land to conserve CVFTL habitat and sand transport systems. a. Support Reserve System assembly to meet CVMSHCP goals and objectives. Conserve additional areas to directly protect occupied habitat, minimize fragmentation and edge effects, create or maintain linkages, and protect ecological processes. b. Identify opportunities for land acquisition outside of conservation areas to conserve habitat and ecological processes. c. Work with local, State, and Federal partners to identify and leverage funding (i.e., section 6) to acquire occupied and potential habitat, and other habitat necessary ecological processes to maintain CVFTL habitat. 3. Maintain or restore CVFTL genetic diversity and connectivity across the species' range. a. Assess and implement options for assisted gene flow. Implement translocation efforts to maintain or restore diversity. b. Identify opportunities to salvage CVFTL where development is planned. Coordinate with partners to plan and implement translocations. c. Continue to monitor genetic metrics (genetic diversity, structure, and effective population size) 4. Adaptively manage CVFTL habitat to maintain or restore habitat quality. a. Treat Sahara mustard within and adjacent to CVFTL habitat. Manage other nonnative species as needed. b. Continue to monitor the pilot restoration at Stebbins Dune. c. Plan and implement further dune restoration as needed to maintain habitat and sand source/transport systems (USFWS, 2023).

Additional Threshold Information:

-
-

References

45 FR 63812. Endangered and Threatened Wildlife and Plants, Listing as Threatened with Critical Habitat for the Coachella Valley fringe-toed lizard. Final Rule. Vol. 45, No. 188. Federal Register 63812. September 25, 1980. Available online at: http://ecos.fws.gov/docs/federal_register/fr476.pdf. Date accessed: February 2, 2016

USFWS (U.S. Fish and Wildlife Service). 1984. Coachella Valley fringe-toed Lizard Recovery Plan. U.S. Fish and Wildlife Service. Portland, Oregon. 74 pp. 1984. Available online at: http://ecos.fws.gov/docs/recovery_plan/850911b.pdf. Date accessed: February 2, 2016

USFWS (U.S. Fish and Wildlife Service). 2010. Coachella Valley fringe-toed Lizard (Uma inornata) 5-Year Review, Summary and evaluation. U.S. Fish and Wildlife Service. Carlsbad, California. 53 pp. August 6, 2010. Available online at: http://ecos.fws.gov/docs/five_year_review/doc3562.pdf. Date accessed: February 2, 2016.

U.S. Fish and Wildlife Service. 1980. Endangered and Threatened Wildlife and Plants

Listing as Threatened with Critical Habitat for the Coachella Valley Fringe-Toed Lizard. Final rule. 45 FR 63812 - 63820 (September 25, 1980).

NatureServe. 2015. NatureServe Explorer, An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available online at: http://explorer.natureserve.org/servlet/NatureServe?searchName=Uma+inornata. Date accessed: February 2, 2016

USFWS (U.S. Fish and Wildlife Service). 2010. Coachella Valley fringe-toed Lizard (Uma inornata) 5-Year Review, Summary and evaluation. U.S. Fish and Wildlife Service. Carlsbad, California. 53 pp. August 6, 2010. Available online at: http://ecos.fws.gov/docs/five_year_review/doc3562.pdf. Date accessed: February 2, 2016. USFWS. 2023. Coachella Valley fringe-toed lizard (Uma inornata) 5-Year Review: Summary and Evaluation. Carlsbad Fish and Wildlife Office Carlsbad, California. 40 pp.

USFWS. (U.S. Fish and Wildlife Service). 2010. Coachella Valley fringe-toed Lizard (Uma inornata) 5-Year Review, Summary and evaluation. U.S. Fish and Wildlife Service. Carlsbad, California. 53 pp. August 6, 2010. Available online at: http://ecos.fws.gov/docs/five_year_review/doc3562.pdf. Date accessed: February 2, 2016.

USFWS (U.S. Fish and Wildlife Service). 1984. Coachella Valley fringe-toed Lizard Recovery Plan. U.S. Fish and Wildlife Service. Portland, Oregon. 1984. Available online at: http://ecos.fws.gov/docs/recovery_plan/850911b.pdf. Date accessed: February 2, 2016

USFWS. 2023. Coachella Valley fringe-toed lizard (Uma inornata) 5-Year Review: Summary and Evaluation. Carlsbad Fish and Wildlife Office Carlsbad, California. 40 pp.