U.S. FISH AND WILDLIFE SERVICE
SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM

SCIENTIFIC NAME: *Heterodon simus*

COMMON NAME: southern hognose snake, southern hog-nosed snake

LEAD REGION: Region 4 (Southeast Region)

DATE INFORMATION CURRENT AS OF: May 7, 2019

STATUS/ACTION

_X_ Species assessment - determined either we do not have sufficient information on threats or the information on the threats does not support a proposal to list the species and, therefore, it was not elevated to Candidate status or proposed for listing

_NA_ Listed species petitioned for uplisting for which we have made a warranted-but-precluded finding for uplisting (this is part of the annual resubmitted petition finding)

_NA_ Candidate that received funding for a proposed listing determination; assessment not updated

_NA_ New candidate

_NA_ Continuing candidate

_NA_ Listing priority number change
Former LPN: __
New LPN: ___

_NA_ Candidate removal: Former LPN: __
___ A – Taxon is more abundant or widespread than previously believed or not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status.
___U – Taxon not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species.
___ F – Range is no longer a U.S. territory.
___ I – Insufficient information exists on taxonomy, or biological vulnerability and threats, to support listing.
___ M – Taxon mistakenly included in past notice of review.
___ N – Taxon does not meet the Act's definition of "species."

___ – Taxon believed to be extinct.

Date when the species first became a Candidate (as currently defined): N/A

Petition Information:
___ Non-petitioned
_X_ Petitioned; Date petition received: July 11, 2012
90-day substantial finding FR publication date: July 1, 2015

FOR PETITIONED CANDIDATE SPECIES:

a. Is listing warranted (if yes, see summary of threats below)?
NA

b. To date, has publication of a proposal to list been precluded by other higher priority listing actions?
NA

c. Why is listing precluded?
NA

PREVIOUS FEDERAL ACTIONS:
On July 11, 2012, we (USFWS- the Service) received a petition from Center for Biological Diversity for 53 amphibians and reptiles in the United States. The petition requested that the southern hognose snake be listed as an endangered species under the Endangered Species Act (Act). On July 1, 2015, the Service published a 90-day finding in the *Federal Register* (80 FR 37568) concluding that the petition presented substantial information indicating that listing the southern hognose snake may be warranted.

ANIMAL/PLANT GROUP AND FAMILY: *Reptile, Colubridae*

HISTORICAL STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: North Carolina, South Carolina, Georgia, Florida, Alabama and Mississippi, USA

CURRENT STATES/COUNTIES/TERRITORIES/COUNTRIES OF OCCURRENCE:
North Carolina: Bladen, Brunswick, Cumberland, Hoke, Moore, New Hanover, Onslow, Pender, Richmond, Robeson, Sampson, Scotland counties
South Carolina: Pender, Richmond, Robeson, Sampson, Scotland counties
Georgia: Baker, Bibb, Burke, Chattahoochee, Decatur, Effingham, Jefferson, Jenkins, Liberty, Long, Marion, McDuffie, Mitchell, Richmond, Screven, Stewart, Talbot, Tattnall, Taylor counties
Florida: Alachua, Bay, Calhoun, Citrus, Columbia, Dixie, Escambia, Franklin, Gadsden, Gilchrist, Hamilton, Hernando, Jackson, Jefferson, Lafayette, Lake, Leon, Levy, Liberty, Madison,

Marion, Okaloosa, Pasco, Santa Rosa, Sumter, Suwannee, Taylor, Wakulla, Walton counties

LAND OWNERSHIP:

Across the range of the species, land ownership varies with many private and public lands. A list of Federal and State lands with known species occurrence have been identified. A table of protected lands shows ownership of these areas if it occurred on publicly-owned land or on privately-owned land designated for conservation uses. We note that this method classified habitat on Department of Defense and other multi-use lands as protected.

Table of Protected lands within the current southern hognose snake range that continue to provide suitable habitat and have occurrence records.

STATE	Manager	Property
NORTH CAROLINA	Dept. of Defense	Fort Bragg
		Camp Lejeune
	State	Sandhills Game Land
SOUTH CAROLINA	U.S. Fish and Wildlife	Carolina Sandhills National Wildlife Refuge
	U.S. Forest Service	Francis Marion National Forest
	Dept. of Defense	Shaw Air Force Base/Poinsett Electronic Combat Range
		Fort Jackson/McCrady Training Center
	Dept. of Energy	Savannah River Site
	State	Sandhills State Forest
		Santee Coastal Reserve
		Tillman Sand Ridge Wildlife Management Area
		Webb Wildlife Center
GEORGIA	U.S. Fish and Wildlife	Eufaula National Wildlife Refuge
	Dept. of Defense	Fort Benning
		Fort Gordon
		Fort Stewart
	State	Big Hammock Wildlife Management Area
		Chattahoochee Fall Line Wildlife Management Area
		Sandhills Wildlife Management Area
		Yuchi Wildlife Management Area
FLORIDA	U.S. Fish and Wildlife	Lower Suwannee National Wildlife Refuge
	U.S. Forest Service	Apalachicola National Forest
	Dept. of Defense	Eglin Air Force Base
		Navy Air Station Pensacola
	State	Ashton Biological Preserve
		Choctawhatchee River Water Management Area

	Dade Battlefield State Historic Site Goethe State Forest Little River Conservation Area Marjorie Harris Carr Cross Florida Greenway State Recreation Area Palatlakaha Environmental and Agricultural Reserve Park Perry Oldenburg Wildlife and Environmental Area Rainbow Springs State Park River Rise Preserve State Park Roy L. Hyatt Environmental Center Subtropical Agricultural Research Station Suwannee Ridge Wildlife and Environmental Area Torreya State Park Troy Spring Conservation Area Twin Rivers State Forest Watermelon Pond Wildlife and Environmental Area Withlacoochee State Forest Withlacoochee State Trail Wood Ferry Conservation Area Yellow Jacket Conservation Area Yellow River Water Management Area Yulee Sugar Mill Ruins Historic State Park

LEAD REGION CONTACT
Timothy Merritt, Chief, Division of Conservation and Classification
Atlanta, Georgia, timothy_merritt@fws.gov, 404-679-7082

LEAD FIELD OFFICE CONTACT
Tom McCoy, Field Supervisor, South Carolina Ecological Services Field Office,
thomas_mccoy@fws.gov, 843–300–0431.

BIOLOGICAL INFORMATION
The Species Status Assessment Report (SSA Report) for the southern hognose snake is a summary of the information assembled and reviewed by the Service and incorporates the best scientific and commercial information available for this species. Excerpts of the SSA Report are provided in the sections below. For further information, please refer to the SSA Report (Service 2019, entire).

Adult southern hognose snake (*Heterdon simus*).
Photo by P. Hill, Florida Fish and Wildlife Conservation Commission.

Species Description

The southern hognose snake is the smallest of the hognose snakes, with adult specimens typically ranging from 33 to 51 centimeters (cm) (12.9-21.8 inches [in.]) with a maximum total length of 74.3 cm (29.25 in.). Adult females are significantly longer than adult males, and males have significantly longer tails than females. Males have 112-122 ventral scales (mean = 115) and tails with up to 44 subcaudal scales; females have 123-134 (mean = 127) ventral scales and 35 or fewer subcaudal scales. In captivity, the current longevity record for the species is 12 years and 42 days (Beane & Thorp, 2007, p. 193).

The species' head is short with a sharply upturned keeled snout. The body scales are keeled and anal plate divided. The head is dusky brown above the snout, with a dark transverse bar that often occurs on the snout in front of the eyes. There is a dark brown or black stripe on either side of the neck and a short dark stripe may occur from the rear of the eye to the corner of the mouth. The dorsum of the body is beige or tan with three longitudinal rows of dark brown blotches outlined anteriorly and posteriorly with black and a light orange to tan stripe along the center of the back. The ventral side varies in color from white, cream, yellowish, or pinkish brown and has faint brownish pigment, usually near the tail. The underside of the tail is the same color as the belly.

Hognose snakes are known for their defensive displays of hissing, flattening their necks, and death feigning. Like other hognose snake species, the southern hognose snake also will hiss and flare its neck when threatened and occasionally roll over and feign death, but it tends to be less theatrical.

Taxonomy

The southern hognose snake was first described in 1766 by Carl Linneaus as *Coluber simus* from a specimen received from Charleston, South Carolina but it has been suggested that Linnaeus may have had an eastern hognose (*Heterodon platirhinos*) in hand. The species was then reassigned to the genus *Heterodon* by Holbrook (1842, p. 57), who went on to describe the species in great detail. There are currently five species recognized within the genus *Heterodon,* all of which are endemic to North America: eastern hognose snake, western hognose snake (*H. nasicus*), Mexican hognose snake *(H. kennerlyi*), dusty hognose snake (*H. gloydi*), and southern hognose snake. The current recommended standard name is southern hog-nosed snake but the USFWS has decided to use the more commonly used name, southern hognose snake. Other names include hissing adder, blow viper, puff adder, spreading adder, and hissing sand snake.

The currently accepted classification of southern hognose snake is:

Kingdom: Animalia
- Phylum: Chordata
  - Class: Reptilia
    - Order: Squamata
      - Suborder: Serpentes
        - Family: Colubridae
          - SubFamily: Dipsadinae
            - Genus/Species: *Heterodon simus*

Habitat/Life History

Habitat

Southern hognose snakes are commonly associated with the longleaf pine ecosystem. They occupy xeric, upland habitat with well-drained, sandy soils, characterized by pine-dominated or pine-oak woodland. They favor habitat where the canopy is open with a grassy understory. The southern hognose snake can be found in multiple physiographic regions across its range. In North Carolina, they have been found in mixed oak-pine forests occurring on well-drained, sandy soils. Typical habitat in North Carolina has been reported as longleaf pine-wiregrass (*Aristrida stricta*)-turkey oak (*Quercus laevis*) forests. Habitat associations for a subset of southern hognose snakes were recorded between 1985-2012; of those records, 51% were found crossing roads between open longleaf pine-wiregrass-turkey oak forests; 12% were found crossing between longleaf pine-wiregrass-turkey oak forests and disturbed forests, old fields, or agricultural areas; and 37% were found crossing roads between various disturbed forests and ruderal habitats (old fields, agricultural plots, clear cuts, and rural yards), or between ruderal habitats.

In Florida, sandhills seem to be the core natural habitat, but snakes have also been found crossing roads near ruderal habitats, such as clearcuts, residential lawns, improved pastures, and old fields. Disturbed habitats are frequently used, but xeric hammock and scrub are seldom used. In a study conducted from 1998-2001 in Hernando County, Florida, half of the

southern hognose snakes observed crossing roads were found near longleaf pine-wiregrass (*A.beyrichiana*)turkey oak forests and 48.7% of snakes were found near old fields, agricultural areas, or disturbed forest types. Near Eglin Air Force Base along the Florida Panhandle, road-killed hatchlings were observed adjacent to longleaf pine-turkey oak sandhill, invaded by native sand pine.

Little is known about any specific habitat requirements that may be needed for nesting and hibernation. The southern hognose snake is strictly diurnal and notably highly fossorial and thus may make little use of aboveground cover. The most rigorous report of the use of burrows discussed finding animals under 20 to 30 cm (7.9 to 11.8 in.) of sand, in open areas, with burrows than can be very obvious. More recently, southern hognose snakes have been reported using southeastern pocket gopher (*Geomys pinetis*) mounds and gopher tortoise (*Gopherus polyphemus*) burrows. It is suspected that they occasionally use the southeastern pocket gopher mounds for sub-surface thermoregulation, particularly on cool, sunny days and may be using the gopher tortoise burrows for both refugia and for foraging for anurans.
We used existing life history literature and expert judgment to identify specific ecological needs for individuals to survive and reproduce. Three main habitat elements, however, appear to be essential to the survival and reproductive success of individuals: well-drained soils, suitable vegetation structure and composition, and presence of prey.

Life history
Life history of a species includes events in a species' life and characteristics that affect the likelihood that an individual will survive and contribute to the population from one year to the next. We consider the southern hognose snake to have three life stages: egg, hatchling/juvenile, and adult.

The annual cycle of the southern hognose snake is characterized by seasonal peaks of activity. Records for the species occur across all months, but there are generally two peak periods of detection (when this species is above ground): breeding season (May-June) and hatchling season (October-November). In Florida, 33.3% of records came from May–June during the breeding season, and 34.5% came from October–November. During a survey in Hernando County, Florida, most snakes were found in June and October–November, with 96% of snakes in October–December being hatchlings. Peak activity was May–June and October in South Carolina and September–October in North Carolina. The southern hognose snake is diurnal, with peak activity occurring in the late morning to early afternoon.

During the first seasonal peak of activity (spring), southern hognose snakes emerge from underground refugia for breeding. It has been speculated that sexual maturity occurs when adults reach 36 cm (14.2 in.) in total length, but others defined an adult as greater than 25 cm (8 in.) snout-vent length. Breeding occurs from mid-April through August, although in North Carolina, the species has been observed breeding in the fall, with observations in late September and early November. The southern hognose snake is oviparous, and in captivity

eggs are usually laid in July and hatch in approximately 60 days (September–October), although oviposition in October has occurred. In captivity, clutch size has been reported as 6–19 eggs with an average of 9.6. Eggs are oval and pale white in color and do not adhere to each other. Hatchlings resemble adults, but their body color and patterning is more pronounced. Hatchling snout-vent length ranges from 13.9 to 14.7 cm (5.5 to 5.8 in.) and total body length from 13.4 to 18.0 cm (5.3 to 7.1 in.).

There is no information available on natural nests, as one has never been found. For the eastern hognose snake, nests were reported at 15 cm (5.9 in.) below the surface in a gravel deposit, under a rock, and at depths of 10 to 15 cm (3.9 to 5.9 in.) in sandy fields. The eastern hognose snake in captivity digs a U-shaped burrow to deposit eggs. There are also little data on hatching success or hatchling survival, although data on the eastern hognose snake suggested high hatching rates.

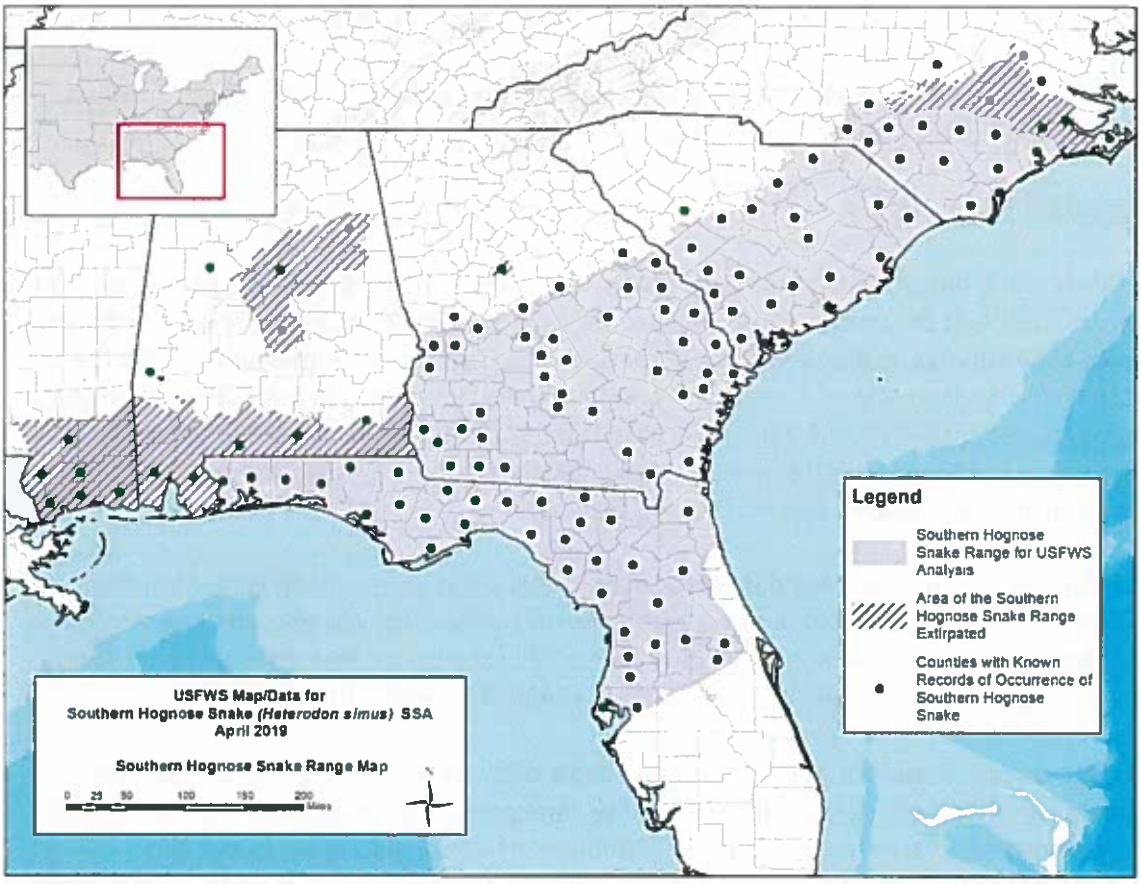
The sex ratio has been reported biased toward males and becomes increasingly biased toward males within the largest size class – a pattern that suggests differential survivorship between the sexes or a sampling bias. Studies of two populations of eastern hognose snakes have also shown a male-biased sex ratio, whereas adults of the western hognose snake exhibit even sex ratios. Hatchlings and juveniles potentially make up a large proportion of a population of the southern hognose snakes, similar to eastern hognose snakes studied in Kansas, and in contrast to the adult-dominated population structure exhibited by western hognose snakes in Kansas. Due to detections being largely along roads during the fall when young have just hatched and are dispersing, care should be taken when interpreting these skewed age ratios as this could be an artifact of sampling bias and further research may be needed.

Foraging Ecology

Frogs and toads (anurans) have been reported to make up the largest portion of the southern hognose snake's diet, but they are also known to eat small lizards. However, a more recent study suggests lizards and anurans may contribute equally to the diet, or a possible diet shift with age or size may happen, due to the fact that lizards have only been found in the stomachs of smaller, juvenile individuals. There have been accounts of southern hognose snakes eating newborn mice in captivity, but they are usually rubbed with an anuran scent to entice the eating of the mouse.

The specialized upturned snout of the southern hognose snake is used to dig out buried prey. Previous gut content analyses showed the presence of mostly eastern spadefoot toad (*Scaphiopus holbrookii*) and six-lined racerunner (*Aspidoscelis sexlineata*). It has been speculated that the southern hognose snake forages in the early morning, before prey, such as the six-lined racerunner, emerges from its nocturnal burrows or during other periods when this lizard is likely to be inactive, such as late evenings or on cool days. It has been hypothesized that the southern hognose snake's enlarged posterior maxillary teeth at the rear of its mouth are used to puncture inflated toads and spadefoots, but the snake is more likely injecting mildly

toxic venom into its prey. In a study of the effects of eastern hognose snake's venom on mice and various anurans, it was noted there were no effects to the mice while most of the anurans died.



Southern hognose snake historic (hashed areas) and current range with counties with known records

Species' Range

Historical Range/Distribution

The southern hognose snake is endemic to the Coastal Plain of the southeastern United States. States with known occurrence records include North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi. The species was historically distributed through the southeastern United States from the vicinities of Morehead City and Raleigh, North Carolina, south to Tampa, Florida; west to the Pearl River separating Louisiana and Mississippi; and north to Calhoun County, Alabama. Historic records are known from two disjoined areas from the rest of the range, with multiple records in Autauga, Shelby, and Calhoun Counties, Alabama up to 1968, and a single historic record from Butts County, Georgia in 1952. Southeastern Louisiana was once included in the historical range for the species, but those records are considered

erroneous. There is also a museum record from Miami-Dade that is far outside of its accepted range; this erroneous reporting can be explained by archival practices. Historic museum records identified the city from which specimens were shipped by the collector, not the site where specimens were actually collected.

Current Range/Distribution
The current range of the species includes southeast North Carolina, eastern South Carolina, southern Georgia, and and northern Florida.

Population Estimates/Status

Due to the cryptic nature of the southern hognose snake and its fossorial (living underground) lifestyle, it is difficult to survey for the species. Southern hognose snakes are typically observed best from road surveys as they tend to use roads during dispersal or movement across the landscape. The Species Status Assessment compiled data from records maintained by Natural Heritage Programs, USFWS, U.S. Forest Service, DoD, State agencies, academic researchers, and HerpMapper (HerpMapper, 2018, unpaginated), which include opportunistic sightings and observations during research and monitoring studies.

Populations for the species were defined as contiguous areas surrounding known southern hognose snake occurrences with habitat conducive to survival, movement, and inter-breeding among individuals within the area. We obtained 2,227 occurrence records from years 1880-2018, which we used to identify 222 populations across the range of the species.

Population estimates are not possible with available data. However, current persistence probability was modeled using habitat suitability, land protection status and the number of nearby populations. To determine habitat suitability, a habitat suitability model was developed. Model results showed habitat suitability, as measured by habitat suitability index (HSI) ranging from 0 (unsuitable) to 1 (most suitable), was strongly influenced by soil characteristics, land cover, and fire interval (see SSA Appendix). The probability of persistence for the southern hognose snake populations served as a proxy for population resiliency. Current range includes areas where populations are at least 50% likely to remain on the landscape.

THREATS
Section 4 of the Act (16 U.S.C. 1533) and its implementing regulations (50 CFR part 424) set forth the procedures for determining whether a species meets the definition of "endangered species" or "threatened species." The Act defines an "endangered species" as a species that is "in danger of extinction throughout all or a significant portion of its range," and a "threatened species" as a species that is "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." The Act requires that we determine whether a species meets the definition of "endangered species" or "threatened species" because of any of the following factors:

(A) The present or threatened destruction, modification, or curtailment of its habitat or range;
(B) Overutilization for commercial, recreational, scientific, or educational purposes;
(C) Disease or predation;
(D) The inadequacy of existing regulatory mechanisms; or
(E) Other natural or manmade factors affecting its continued existence.

These factors represent broad categories of natural or human-caused actions or conditions that could have an effect on a species' continued existence. In evaluating these actions and conditions, we look for those that may have a negative effect on individuals of the species, as well as other actions or conditions that may ameliorate any negative effects or may have positive effects.

We define "threat" as any action or condition that is known to or is reasonably likely to negatively affect individuals of a species. This includes those actions or conditions that have a direct impact on individuals, as well as those that affect individuals through alteration of their habitat or required resources. The mere identification of "threats" is not sufficient to compel a finding that listing is warranted. Describing the negative effects of the action or condition (i.e., "threats") in light of the exposure, timing, and scale at the individual, population, and species levels provides a clear basis upon which to make our determination. In determining whether a species meets the definition of an "endangered species" or a "threatened species," we have considered the factors under section 4(a)(1) and assessed the cumulative effect that the threats identified within the factors—as ameliorated or exacerbated by any existing regulatory mechanisms or conservation efforts—will have on the species now and in the foreseeable future.

However, the mere identification of any threat(s) does not necessarily mean that the species meets the statutory definition of an "endangered species" or a "threatened species." In determining whether a species meets either definition, we must evaluate all identified threats by considering the expected response by the species, and the effects of the threats—in light of those actions and conditions that will ameliorate the threats—on an individual, population, and species level. We evaluate each threat and its expected effects on the species, then analyze the cumulative effect of all of the threats on the species as a whole. We also consider the cumulative effect of the threats in light of those actions and conditions that will have positive effects on the species—such as any existing regulatory mechanisms or conservation efforts. The Secretary determines whether the species meets the definition of an "endangered species" or a "threatened species" only after conducting this cumulative analysis and describing the expected effect on the species now and in the foreseeable future.

Any factor that impacts the southern hognose snake's physical habitat, quality of its habitat, or that otherwise affects population densities will likely have a deleterious effect upon the species. We considered the following factors that affect the species: habitat loss, conversion, and fragmentation; road mortality; invasive species; the effects of climate change; persecution,

harassment, and the pet trade; and disease. Habitat loss, conversion, and fragmentation, road mortality, climate change, persecution, harassment, collection for the pet trade, and invasive species are considered the primary sources of stressors on the southern hognose snake. Although negative effects due to disease have not been demonstrated specifically in this species, this potential stressor is likely to result in episodic impacts to populations.

Habitat Loss, Conversion, and Fragmentation

Loss of Longleaf Pine Ecosystem

The southern hognose snake is associated with longleaf pine savanna, particularly xeric uplands that were historically maintained by fire. The longleaf pine ecosystem is a fire-dependent ecosystem that once dominated the Coastal Plain of the Atlantic and Gulf coast regions, from Virginia to Texas. The longleaf pine uplands once covered an estimated 92 million acres. By the 21st century, the longleaf pine community had declined to less than three million acres due to forest clearing and conversion for agriculture, silviculture (tree farming), and development. Little old-growth longleaf remains, and of the uplands that remain, only about 3% are in relatively natural condition due to the exclusion/suppression of naturally-occurring wildfires.

Original longleaf pine communities were old-growth, open-canopied, and contained a structure of two layers: canopy and diverse herbaceous groundcover. Frequently burned, the natural condition was a canopy cover that rarely exceeded 60 percent and permitted a grassy groundcover to flourish. In contrast, much of today's forest is young, dense, and dominated by loblolly pine (*Pinus taeda*), with a substantial hardwood component and little or no herbaceous groundcover. The longleaf ecosystem was first heavily altered by exploitation for naval stores and then virtually eliminated by widespread logging. Naval stores industries harvested pine resin for the production of tar, pitch, and turpentine—commodities in high demand during colonial times. Pine woodlands were logged for lumber and converted to agricultural fields. Impacts to easily accessible areas began with the arrival of Europeans, but technological developments of the 1800s, such as the copper still, steam power, and especially railroads, dramatically increased the rate and area of loss. In the late 1800s, logging operations moved to the previously inaccessible interior forests of longleaf, shortleaf (*Pinus echinata*), and loblolly pines. This especially intense period of logging from 1870 to 1930 resulted in the loss of nearly all of the remaining old-growth forest in the Southeast. Since this historic loss of old-growth forest, the trend has been reversing and we now have areas of loblolly pine and other open pine systems scattered throughout the range of the species.

Although there is still uncertainty in burn regimes between various habitat types and along environmental gradients, fire frequencies in longleaf pine savanna have been estimated at one to three years. Frequent burning has been shown to maintain species richness of the ground cover layer. Season of fire also has important effects on vegetation composition. Growing season burns, generally defined as the period of time when most plants are actively growing, coincides with the bulk of wildfires caused by lightning strikes, and has been shown to better

meet management objectives for longleaf pine forests.

Historically, lightning was the primary ignition source shaping the evolution of these fire-maintained ecosystems, but Native Americans may have played a role in maintaining them. After European settlement and prior to the mid-1800s, farmers burned the woodlands regularly to improve forage for free-ranging livestock, but by the mid to late 1800s fencing of livestock caused a decrease in burning. Although many people continued to use fire in agricultural fields well into the 1900s, the rise of mechanical and chemical agriculture replaced fire-based agricultural methods.

Active fire exclusion/suppression began to be institutionalized in the southeastern United States between 1910 and 1930. Some foresters denounced fire as detrimental to southern pines rather than an integral or useful component of the natural system. Fire suppression increased with the rise of pine plantations, a land use that began in the 1930s. Due to the suppression of lightning-ignited fire and the natural disturbance fires provide, longleaf pine communities have converted to fire-intolerant trees and shrubs that eventually shade out the ground cover and render the forest unsuitable for much of the fire adapted biota. In addition to directly affecting reptiles, habitat loss can indirectly affect them by limiting their ability to meet ecological needs for survival and reproduction.

Like other reptiles and amphibians associated with the longleaf pine ecosystem, the southern hognose snake has declined in parallel with the decline of the longleaf pine ecosystem. Although the southern hognose snake is more common in sandy, open longleaf pine forests and flatwoods, it can persist in fragmented and altered habitats. The effects of habitat conversion to agriculture on long-term viability of the species is unknown. Many southern hognose snakes have been found on roads near disturbed habitats such as clearcuts, residential lawns, improved pastures, and old fields and agricultural areas. Agricultural areas where snakes are being detected have an open canopy and the presence of sandy soils. In addition, agricultural practices, such as plowing and other soil disturbing activities, may cause direct mortality to southern hognose snakes due to their fossorial (adapted for digging) nature and may alter the soil profile or characteristics, rendering soils less suitable for snakes. Southern hognose snakes are more commonly found in fire-maintained upland habitat than agriculture areas, and when found in agricultural areas those areas are typically adjacent to natural upland habitats. It is likely that natural upland habitats are optimal for individuals' survival and reproduction while agriculture and other low-impact areas of human use (e.g., pastures, pine plantations, rural and urban open areas) support survival and movement through these areas but may not support long-term viability of populations.

Timber stands with high stand density and a dense mid-story with little to no groundcover do not provide adequate habitat for the southern hognose snake, but it should be mentioned that thinning dense stands of forest, as opposed to clear cutting, can benefit species that occupy longleaf forests. Thinning of dense stands can help mimic the historic condition of longleaf

stands, mainly through the opening of the under- and mid-story.

Urban Development

Urbanization plays both direct and indirect roles in the decline of many species. Urbanization fragments and replaces natural habitats with artificial structures, impervious concrete and asphalt surfaces, manicured lawns, and gardens full of exotic plant species, and increases levels of air, water, noise, and light pollution, putting the survival of many wildlife species in jeopardy. Snakes seem to be particularly sensitive to effects of urbanization, and this intolerance has played a key role in the general declines reported for reptile species around the world.

Urbanization impacts many wildlife species from direct loss of habitat, fragmentation of habitat, increased road mortality, increased human persecution, and the increase in domestic predators, such as cats (*Felis catus*) and/or dogs (*Canis lupus familiaris*). Also, a combination of urban sprawl and migration of humans to rural areas has created an extensive wildland-urban interface (WUI), the area where houses and wildland vegetation meet or intermingle. Wildland-urban interfaces limit the ability to conduct prescribed fires due to issues associated with smoke management and fear of fires escaping and having catastrophic effects. Active fire exclusion/suppression and a lack of a controlled burning program in WUIs results in increased fuel loads and a subsequent increase in the likelihood of future destructive fires. Furthermore, because of constraints on implementing prescribed fire in WUIs, there is an increased risk of habitat degrading to the point that it is unsuitable for southern hognose snakes due to woody species encroachment.

In the southeastern United States, projections predict the urban footprint will greatly increase over the next 50 years, with median projections showing that the amount of land in urban areas will increase by 139% by 2060. Urbanization is not predicted to be uniform across the region. The largest urban expansions are projected in the Blue Ridge, Ridge and Valley, Southern Coastal Plain, and Piedmont ecoregions, and new urban centers are projected in the Appalachian Mountains and central Florida regions.

Many "hotspots" of projected urban development are predicted to occur within or near known occurrence records for southern hognose snakes or predicted suitable habitat. Although we do not know the exact response of the southern hognose snake to various levels of urbanization, we do know that urbanization will likely result in the loss, degradation, and fragmentation of habitat, increased amount of WUI, increased persecution by humans, increased road mortality, and increases in domestic predators. In the case of domestic predators, killing by domestic dogs has been noted. Additionally, urbanization increases the number of mesopredators, such as raccoons (*Procyon lotor*), potentially impacting southern hognose snakes through direct predation or through indirect means by potentially affecting their prey base. Thus, we consider urbanization to be a significant threat to the southern hognose snake.

Fragmentation

Human induced disturbances, particularly from land use changes discussed in the previous sections, not only have the potential to result in loss or degradation of habitat, but also fragmentation of habitat. Habitat fragmentation is the breaking apart of continuous habitat into multiple patches. Forestry and urban development increase the prevalence of roads and associated infrastructure, which increase the fragmentation of the habitat and additionally result in increased mortality from increased vehicular traffic. Fragmentation can have a variety of negative impacts on wildlife, including greater mortality rates associated with landscape modifications (e.g., roads), more frequent encounters with humans, reduced resources in smaller patches, reduced reproduction, restricted gene flow, and increases in predation and competition. Reduction of larger habitat patches into smaller patches can lead to population declines due to limited resource availability and can also negatively affect day-to-day movement. Fragmentation may also negatively affect larger-scale movements such as dispersal and seasonal migration.

Many snake species are likely to be sensitive to habitat fragmentation because they occur in low densities, have limited dispersal abilities, have thermal constraints, and are subject to direct and indirect mortality caused by humans. Of particular concern is the role that roadways play in fragmenting habitat. Depending on the size and traffic volume, newly-constructed roads can effectively become barriers that divide and isolate populations. The increasing encroachment of roads into natural areas may isolate populations, prevent movement between nest sites and hibernacula, restrict gene flow, and limit access to mates. Additionally, roads not only impinge on life history requirements of species but also facilitate other threats, such as conversion of more habitat, creation of roads for access, and the spread of invasive species, and lead to increases in direct mortality, discussed in the next section. Using population viability analyses, eastern indigo snake (*Drymarchon couperi*) populations were predicted to be vulnerable to extinction in fragmented conservation areas bordered by roads and suburbs.

How individuals move between patches and how they respond to different habitats will ultimately determine how populations are impacted by fragmentation; thus, few generalizations can be made about the effects of habitat fragmentation on individual species. One might expect relatively sedentary species, such as the southern hognose snake, with specialized habitat requirements to be vulnerable to habitat fragmentation. Direct data is unavailable on the impact of habitat fragmentation on the southern hognose snake, but it has been hypothesized that habitat fragmentation is the cause for regional eastern hognose snake declines.

Road Mortality

As discussed above, roads create habitat fragmentation, isolate populations, pose a barrier to movement, and increase direct mortality for many snake species. Snakes are more severely affected by road mortality than other animal groups because they are thought to use roads for thermoregulation, are relatively slow-moving, and tend to arouse fear in the general public,

leading to intentionally being run over. It has been observed that reptiles are struck by vehicles at a greater rate than would be expected by chance, suggesting that drivers intentionally target reptiles on roads. It has been estimated that vehicular traffic has killed tens or hundreds of millions of snakes in the United States throughout history.

An increase in the number of mortalities from vehicles may reduce genetic diversity, decrease potential for dispersal into fragmented habitats, and alter demographics of the surrounding population – all of which can lead to declines or extirpation of populations of snakes. One study of black ratsnakes (*Pantherophis obsoletus*) found that, when including an estimate of road mortality to a population viability analysis, the extinction probability increased from 7.3% to 99% over 500 years. An increased mortality rate for different reproductive classes can have profound consequences for a population; for example, increased mortality of females can reduce a population's growth rate more than mortality of males.

A snakes' vulnerability to vehicle encounters is highest when they travel outside of their normal home range, with the highest mortality occurring in adult males during the mating season, neonates or hatchlings immediately after birth or hatching, and adult females on egg laying migrations. Roads that bisect high quality habitat have higher levels of mortality than those that bisect lower quality habitat. Snake populations could experience especially high levels of road mortality during periods where high traffic volumes and species' seasonal movements coincide.

Due to the secretive nature of the southern hognose snake and the difficulty in surveying for them, many records of this species are from encounters on roads; additionally many of those records are documented as Dead on Road (DOR). In North Carolina, during road surveys conducted between 1985–2012, 764 southern hognose snakes were detected; of those detections, 643 (84%) were observed DOR, 110 were observed Alive on Road (AOR), and 11 were encountered incidentally, not on a road. Observations in Florida between 1998-2001 detected 39 southern hognose snakes, all of which were DOR, and 62% of those observations were juveniles. The majority of southern hognose snakes encountered on North Carolina roads tend to be juveniles.

Their cryptic coloration; small size; and aspects of their behavior such as slow movement, remaining motionless, and death feigning, lend this species to be particularly susceptible to road mortality compared to other snake species. Behavioral observations for a subset of southern hognose snakes found AOR in North Carolina support this idea. Many individuals encountered on roads would "freeze" and remain motionless when approached, whereas others would continue crawling very slowly, often in a characteristic hesitant, jerky fashion, and only a few individuals, mostly juveniles, would attempt to crawl away rather rapidly. It was also estimated that it takes the southern hognose snake 7.69 minutes to cross a typical two-lane road. We do not know the full impact that road mortality may play on this species, but the high number of observed DOR provides evidence that road mortality is occurring at a rate that is

likely having population level effects and contributing to population declines in parts of the species' range.

Invasive Species

Red Imported Fire Ants

Introduction of non-native species are increasingly common, but the long-term consequences of these introductions are still poorly known. The red imported fire ant (RIFA; *Solenopsis invicta*), originating from South America, was first introduced as early as 1918 to the United States at the port of Mobile, Alabama, and subsequently spread from there.

Red imported fire ants can multiply rapidly and infiltrate disturbed and early-successional habitats. Reptiles are particularly susceptible to red imported fire ants. Many species of reptiles are oviparous (egg-laying) and their eggs can be depredated by red imported fire ants, both pre- and post-hatching. In addition, many reptile species inhabit disturbed areas, which red import fire ants prefer, and excavate nests, creating disturbance and providing scent that attracts red imported fire ants. Species that nest under or on the ground and in or near open habitat may be more negatively affected by red imported fire ants. Red imported fire ants are aggressive and their stings can result in direct mortality along with reduced survival by preventing weight gain, altering behavior, changing foraging patterns, reductions in food availability, and altered habitat.

Red imported fire ants have been linked to population declines of several native species, including the Houston toad, (*Bufo houstonensis*), bobwhite quail (*Colinus virginianus*), Texas horned lizard (*Phrynosoma cornutum*), and have been proposed as contributing to the decline of the southern hognose snake.

The apparent declines and extirpations of the southern hognose snake are concurrent with the range expansion of red imported fire ants in the Southeast. Portions of the snake's range within the Coastal Plains of Mississippi, Alabama, and the Florida Panhandle had become infested with red imported fire ants by 1958 and would be the first to experience the full impact of red imported fire ant predation. The last detections for southern hognose snakes in Mississippi were 1981 and 1975 for Alabama. There is some speculation that a time lag occurs from when an area becomes heavily infested with red imported fire ants and the impacts become obvious. It should be noted that red imported fire ants have difficulty establishing colonies in excessively sandy soils; in such habitat, the impact would be less severe than in those capable of supporting dense populations of red imported fire ants. This may help explain why southern hognose snakes were extirpated from Mississippi and Alabama. Besides always being rare in that portion of their range, the soils are generally wetter west of the Mobile basin and are not as deep as the sandy soils in other portions of the range. Wetter soils are more readily colonized by red imported fire ants. Thus, in that portion of the range red imported fire ants were possibly one of the main factors leading to their extirpation. This also might help explain why southern hognose snakes continue to occupy areas like the Florida Ridge that have

the deep sandy soils.

The southern hognose snake may be particularly susceptible to red imported fire ants because of its small size, slow speed, use of open, disturbed habitats, and the fact that it is a burrowing species. Southern hognose snakes also rely heavily on crypsis and immobility as an antipredatory defense, which in the case of red imported fire ants does not work to fend off the attack. There are examples of other reptiles exhibiting immobility when exposed to fire ants, as was the case in fence lizards (*Sceloporus undulatus*) where those lizards that had longer history with red imported fire ants were more likely to exhibit defensive behavior and quickly flee from them. It is possible that the slow, cryptic behavior of the southern hognose snake has become maladaptive in the presence of red imported fire ants, creating an evolutionary trap that has contributed to its decline.

Feral Hogs

Feral hogs (*Sus scrofa*) negatively affect almost all aspects of ecosystem structure and function and are known to have significant impacts to native animal and plant communities through direct consumption and indirectly through rooting and soil disturbance. Reptile species are particularly susceptible to impacts from feral hogs. In addition to causing direct mortality to reptiles and amphibians, feral hogs also have indirect effects on populations through rooting and habitat alteration. Their rooting disturbs soil layers and natural decomposition cycles, which can lead to changes in nutrient cycling.

A study at Fort Benning, Georgia found that an entire population of feral hogs (i.e., estimated to be 3,196 individuals) could consume 3.16 million reptiles and amphibians per year. For southern hognose snakes, feral hogs could be a predator, particularly while foraging around wetland edges where snakes are searching for anuran prey. Feral hogs could also be impacting frogs and toads, a critical prey base of the southern hognose snake. For example, the eastern spadefoot toad remains underground for most of the year, but emerges on warm, rainy nights to breed during the spring and summer months in the southeastern United States. During these periods of breeding, eastern spadefoot toads are found at extremely high densities, and it is possible that feral hogs respond to this concentrated food source and focus their hunting on these spadefoot toads. There are concerns that this selective foraging by feral hogs could threaten not only spadefoot toad populations but also other species that have a similar life history and impact other species further up the food chain, such as southern hognose snakes. The range of feral hogs in the contiguous United States overlaps with the range of the southern hognose snake.

Climate Change

In the southeastern United States, climate change is expected to result in more frequent drought, more extreme heat (resulting in increases in air and water temperatures), increased heavy precipitation events (e.g., flooding), more intense storms (e.g., frequency of major hurricanes increases), and rising sea level and accompanying storm surge. Warming in the

Southeast is expected to be greatest in the summer, which is predicted to increase drought frequency, while annual mean precipitation is expected to increase slightly, leading to increased flooding events. Changes in climate may affect ecosystem processes and communities by altering the abiotic conditions experienced by biotic assemblages resulting in potential effects on community composition and individual species interactions. These changes have the potential to impact southern hognose snakes and/or its habitat.

Despite the recognition of climate effects on ecosystem processes, there is uncertainty about what the exact climate future for the southeastern United States will be and how the ecosystems and species in this region will respond. It should be recognized that the greatest threat to many species from climate change may come from synergistic effects. That is, factors associated with a changing climate may act as risk multipliers by increasing the risk and severity of more imminent threats.

Terrestrial ectotherms, such as the southern hognose snake, may be at particularly high risk from climate change because they are less effective at buffering body temperature against ambient temperature using physiological mechanisms, and instead rely heavily on ambient thermal heterogeneity to regulate their temperature behaviorally, resulting in their growth, locomotion and reproduction being strongly dependent on their body temperature. For example, southern hognose snake reproduction is tied to seasons with suitable temperature and moisture regimes, and altered weather conditions during these seasons may result in frequently recurring "bust" years of reproductive failure, and ultimately population declines. Also, it has been shown that high temperatures that restrict foraging activity by reptiles can lead to energy shortfalls, and ultimately reduced population growth. Reptile species with specialized diets, such as the southern hognose snake, could be particularly vulnerable to changes in climate that affect their prey base. Populations of southern hognose snakes could decline in response to drought-induced population declines of frogs and toads, their primary prey.

The most substantial impacts from climate change on the southern hognose snake are likely habitat based. Current and continued projected warming will increase the risk of wildfire, insect, wind, and disease damage to southeastern forests, and limit the number of suitable days to implement prescribed fire. For example, predicted longer growing seasons will likely increase the risk of insect outbreak and very likely will expand the northern range of some species, such as the southern pine beetle (*Dendroctonus frontalis*).

The Southeast leads the nation in number of wildfires per year, and climate change will likely increase the frequency and intensity of wildfires. The projected temperature increase across the Southeast will likely contribute to increased fire frequency and intensity, total burned area, change in fuel conditions, and longer fire seasons. Alternatively, constraints to managing southern hognose snake habitat with prescribed fire is likely the most substantial risk factor associated with climate change for this species. Predicted changes in temperature and

precipitation due to climate change will limit the number of days with suitable conditions for controlled burns, and combined with issues associated with WUIs discussed earlier, will further constrain the ability to manage habitat with prescribed burning. As the ability to implement prescribed fire becomes further constrained, the ability to reduce woody vegetation and maintain an open under- and mid-story will be severely limited, and southern hognose snake habitat will likely degrade.

Additionally, there is risk to coastal populations of the southern hognose snake due to sea level rise (SLR) under climate change. Global mean sea level has risen about 7-8 inches (16-21 cm) since 1900, with about half of that rise occurring since 1993. In areas of the Southeast, tide gauge analysis reveals as much as 1 to 3 feet (0.30 to 0.91 meters) of local relative SLR in the past 100 years. The future estimated amount that sea level will rise depends on the response of the climate system to warming, as well as on the future scenarios of human-caused emissions. Coastal populations of southern hognose snakes are predicted to be directly impacted by inundation of upland habitat directly along the coast by rising sea levels, resulting in loss of habitat. Although the amount of habitat predicted to be lost within a given population due to SLR varies considerably depending on the location of the population, 50 southern hognose snake populations are considered to be vulnerable to SLR (i.e., population is anticipated to lose some amount of suitable habitat under all SLR scenarios). Loss of suitable habitat within a population will result in a decreased probability that a given population will persist.

Persecution, Harassment, and the Pet Trade

Humans have a long history of fearing snakes. Fear of snakes, called ophiophobia, has made snake conservation more difficult than other vertebrate groups. The negative perception of snakes ranges from low interest, to harassment, to deliberate killing of them. Unfortunately, many human-snake encounters result in the death of the snake. Due to the hognose snake's defensive behavior of flattening their head like a cobra, opening their mouth, and hissing loudly, they tend to be viewed as a threat to humans and thus when encountered in the wild they may be killed by people who do not know they are harmless.

There has also been an increase in recreational herpetology by enthusiasts actively looking for the southern hognose snake because it is considered an uncommon species and they want to add this species to their life list. With the rise of social media there has been an increase of public knowledge of roads where it is easy to spot these animals. September and October, the most common months the species can be found, has become known as "Hogtober". These hobbyists may not be collecting individuals, rather just photographing and releasing, but this increased harassment may cause individuals increased stress that could be detrimental to them. Additionally, the increase in traffic on the roads from hobbyists leads to increased road mortality for the species.

Hognose snakes have been in the North American pet trade dating back to the late 1980s and into the 1990s, but within the last several decades their numbers in the pet trade have

expanded. Many view hognose snakes as desirable pets due to their upturned snout and coloration making them aesthetically attractive, as well as their tendency to seldom bite, unless a hand or finger is mistaken for food. Endearing nicknames such as "hoggies" and the fact that they are rear fanged, carry mild venom, and will play dead, add to their mystique as pets. Western hognose snakes comprise most of the pet trade, with eastern and southern hognose snakes having a smaller commercial role. This may be because both the eastern and southern hognose snakes eat predominantly frogs and toads, and breeding in captivity can be more problematic for the southern hognose snake. However, there is evidence that collection for the pet trade is a threat to this species. From 1990–1994, 135 wild-caught southern hognose snakes were reportedly sold in Florida, collected on primarily four areas of Florida roads where they were relatively abundant. Although there is some potential that some of these snakes were misidentified and were actually eastern hognose snakes, this shows that there is a demand for the southern hognose snake in the pet trade. Since the 1990s, the demand for this species continues to remain in the pet trade and hatchlings often sell for more than $200 at reptile shows. In Florida, two areas of Madison and Suwannee counties are well known to snake hunters for sometimes producing red-colored individuals that are worth up to $500. Though the population impact of collecting southern hognose snakes from roads is unknown, social media has allowed rapid dissemination of locations of prime or new collecting areas, and commercial or recreational snake hunters may come from hundreds of miles away to look for this species.

Disease

In wild populations of reptiles, debilitating diseases are most likely secondary expressions in individuals with impaired resistance caused by one or more primary environmental stressors, such as habitat degradation, invasive species, or pollution. These primary environmental stressors can lead to immune suppression, which can further lead to an increase in morbidity and mortality from infectious disease. Over the past several decades, the number of emerging fungal diseases and the number of species extinctions and extirpations caused by those diseases has increased. For example, recent literature suggests that chytrid fungus (*Batrachochytrium dendrobatidis*) has played a role in the decline of at least 501 amphibian species over the past half century and potentially caused 90 extinctions

Snake fungal disease (*Ophidiomyces ophiodiicola*) is a serious emerging fungal pathogen of endemic North American snakes and can persist in soil as well as colonize living hosts. First noted in 2006 as a severe skin infection associated with a precipitous decline in timber rattlesnakes (*Crotalus horridus*) in the northeastern United States, snake fungal disease has since been implicated in widespread morbidity and mortality across the eastern United States. Infected wild snakes have several distinct lesions on various parts of the body, head, or tail, and often the animal will die from complications from the infection rather than from direct fungal damage. Snake fungal disease has been most often observed in pit vipers; however, the disease has been detected on the skin of captive and free-ranging snake species representing 12 genera within two families, including colubrid snakes. Snake fungal disease has been detected in at

least 23 states and one Canadian province, though there is some speculation that it may be more widely distributed than the documented cases suggest because the efforts to monitor the health of many snake populations are limited. To date, there have been no documented cases of snake fungal disease in southern hognose snakes; however, the disease has been detected in every State within the species' current range. The impact of snake fungal disease on snake populations is currently unknown, but the effects of infectious diseases on wildlife populations are an increasing concern, especially for species persisting at small population sizes.

Conservation Measures

Conservation Lands

Suitable habitat for southern hognose snakes can be found within National Wildlife Refuges, National Forests, State Lands, and other conservation areas across the species' range. Habitat improvements, including ecosystem restoration, enhancement, protection, prescribed burning, and mechanical upland habitat restoration conducted across the species' range have likely provided some benefits to the southern hognose snake. Most conservation lands owned by Federal and State agencies are expected to remain protected and managed for conservation purposes in the near future, which would eliminate the risk of direct loss of habitat to urbanization in these areas.

Many of these conservation lands in which southern hognose snakes occur, manage habitat for other longleaf-associated species, such as red-cockaded woodpeckers (*Picoides borealis*) and gopher tortoises (*Gopherus polyphemus*). This habitat management likely has some benefits to the southern hognose snake when the managed habitat results in an open canopy system with more diverse groundcover.

Thirty-one percent of all occurrence records for the southern hognose snake occur on protected lands. The percentage increases to 77% of all occurrence records when including records that occur within a kilometer of protected lands. This percentage may not reflect the proportion of individual snakes on protected lands because opportunities to detect the species on public lands are better. However, it may indicate that habitat suitable for the species is more prevalent on protected lands, or it could be a combination of the two. Still, based on the best available information, protected lands play an important role for this species.

Department of Defense

Throughout the Southeast, 10 military installations have records of southern hognose snakes, and an additional 26 installations could potentially have them. Active prescribed burning programs are implemented on most military installations to manage for longleaf pine ecosystems, which can benefit conservation of the southern hognose snake. As part of implementation of the Sikes Improvement Act (1997), the Secretaries of the military departments are required to prepare and implement Integrated Natural Resource Plans (INRMP) for each military installation in the United States. No installations specifically include

southern hognose snake habitat and population management prescriptions and goals within their INRMPs; however, most of the INRMPs do include specific management for other longleaf species such as the red-cockaded woodpecker and gopher tortoise, which would provide some benefit to southern hognose snakes. The Department of Defense's Readiness and Environmental Protection Integration (DoD 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, restore, and maintain longleaf pine habitat across the Southeast.

Longleaf Ecosystem Conservation and Restoration

Department of Defense, U.S. Forest Service, USFWS, and multiple state agencies are all active partners in America's Longleaf Restoration Initiative. This is a collaborative effort of multiple public and private sector partners that actively supports range-wide efforts to restore and conserve longleaf pine ecosystems with a 15 year goal to increase longleaf from 3.4 to 8.0 million acres. These efforts are focused within 16 "significant landscapes". Within these significant landscapes, Local Implementation Teams (LITs) are leading conservation efforts by coordinating partners, developing priorities, and fundraising to implement on-the-ground conservation. The majority of LITs are working within the range of the southern hognose snake, and each of these LITs has components of their conservation plans that support restoration of longleaf habitat and play an important role in southern hognose snake habitat restoration and management.

Throughout the range of the southern hognose snake, several Candidate Conservation Agreements with Assurances (CCAA) have been or are in different stages of being developed. Candidate Conservation Agreements with Assurances are voluntary commitments made by non-Federal partners to undertake actions that will remove or reduce threats to candidate or other at-risk species. The goal of any CCAA is to provide a net conservation benefit to the covered species and to preclude the need to list species under the ESA. As an incentive to the non-Federal property owner who engages in voluntary conservation actions for a particular species or group of species, landowners are given regulatory assurances if the species is listed under the ESA. Three such agreements we are currently aware of that could provide potential benefits to the southern hognose snake are described below.

Camp Blanding Joint Training Center, in Florida, signed a Candidate Conservation Agreement with Assurances (CCAA) with the USFWS and the Florida Fish and Wildlife Conservation Commission to manage enrolled lands in the agreement to benefit multiple species, including the southern hognose snake. There are no records of southern hognose snakes at Camp Blanding; however, there is suitable habitat on the installation and surrounding area.

The Quail County Programmatic CCAA for North Florida and Southwest Georgia, not currently finalized, is an agreement between the USFWS, Florida Fish and Wildlife Conservation

Commission, and Georgia Department of Natural Resources, in cooperation with Tall Timbers Research Station. This programmatic CCAA aims to enroll landowners to manage lands to the benefit of the covered species, including the southern hognose snake.

In South Carolina, the USFWS and the South Carolina Department of Natural Resources are developing the South Carolina's Southern Pinelands Programmatic CCAA to benefit multiple priority pineland species, including the southern hognose snake. If implemented this programmatic CCAA would allow enrolled landowners to manage lands in a way that will benefit the southern hognose snake and provide them with regulatory assurances if the species is listed under the ESA. This agreement is still in the planning stages.

State Protections

The southern hognose snake is listed as State threatened in North Carolina, South Carolina and Georgia, State endangered in Alabama and Mississippi, and not listed in Florida. In Florida, the species is ranked as a species of greatest conservation need.

Current Condition

The viability of the species is based on population resiliency, species redundancy and representation across its range. Resiliency provides for the ability of a population to withstand stochastic variability and the availability of resources or population dynamics for the species to persist. For the purpose of the analysis, populations were defined as contiguous areas surrounding known southern hognose snake occurrences with habitat conducive to survival, movement, and inter-breeding among individuals within the area. We compiled all species records gathered for the habitat analysis in GIS and included every record regardless of observation year. To delineate populations, we used records with available latitude and longitude information. County records (n=27) that were lacking coordinates were placed at the county's centroid and included as populations, assuming that at some point in time southern hognose snakes occurred within that county somewhere on the landscape. Then we buffered the species occurrence records by 5 kilometers (km) (3.1 miles) and divided contiguous areas by large rivers and interstate roads that likely prevent movement and interbreeding among individuals on opposite sides of the barrier.

Current resiliency, as measured by population persistence probabilities, for the southern hognose snake has decreased from historical conditions. We considered a population to be highly resilient if it had a relatively high current persistence probability. The southern hognose snake only has 22.1% of its total populations exhibiting the highest degree of resiliency and has likely experienced a loss of 60% of its total populations. The remaining populations have varying degrees of resiliency.

Number and percentage of southern hognose snake populations in each persistence category and cumulative number of populations at or above each threshold.

Population persistence	Number of	% of	Cumulative number of	% of

	populations in each category	total	populations at or above each threshold	Total
Extremely Likely on Landscape (Extant) 95-100%	49	22.1%	49	22.1%
Very Likely on Landscape 80-94.9%	19	8.6%	68	30.6%
More Likely than Not 50-79.9%	21	9.5%	89	40.1%
Unlikely < 50% (Extirpated)	133	59.9%	-	-
Total	222	100%		

Representation reflects the ability of a species to adapt to changing environmental conditions and can be measured by the breadth of genetic or environmental diversity within and among populations. For the southern hognose snake, we do not have information related to genetic diversity. In the absence of species-specific genetic and ecological diversity information, representation can be assessed based on the extent and variability of habitat characteristics across the geographical range. Ecoregions are a system of classification based on physiography, where areas with similar characteristics of land formation, dominant soil and vegetation types, climate, air and sea currents, and distribution of flora and fauna are grouped into a single ecoregion (Bailey, 1983, entire; Bailey, et al., 1994, entire). Ecoregions have been used to reflect broad areas within which local adaptations and genetic coadaptation have likely occurred. Therefore, we used ecoregions to act as an appropriate proxy for factors likely to influence the adaptive capacity of southern hognose snakes across the landscape. We broke the southern hognose snake range into nine representative units based on grouping Environmental Protection Agency (EPA) Level IV ecoregions by similar ecological characteristics (e.g., soil, geology) and divided them by the Savannah, Chattahoochee, and Mobile-Tombigbee Rivers where appropriate.

Current representation, as measured by the number and distribution of resilient populations (i.e., those above a certain persistence probability threshold) across representative units in the species' range has also decreased from historical conditions. To have high representation the species must have highly resilient populations located in each of the representative units, and those occupied units should span the latitudinal and longitudinal extent of historical populations. The southern hognose snake has experienced a complete loss of two representative units, one additional representative unit is at risk of becoming extirpated, and all the remaining units are showing declines in the number of resilient populations. There has been a loss of latitudinal and longitudinal variability within the range as all of the populations at the northeastern and western extent of its range have been extirpated.

Current redundancy, as measured by using the current number and distribution of resilient populations within representative units and across the range of the species has been reduced from historical conditions. To have high redundancy the species needs to have multiple resilient populations within representative units and throughout its range. Each of the 9 representative units has likely lost at least 50% of its populations. Range-wide, the number of populations more likely than not to currently persist has decreased by 60%, relative to the historical number of populations. The southern hognose snake has experienced a decline in the number of resilient populations within each of the representative units and across its entire range. Additionally, the distribution of resilient populations within each unit and across the range has become clustered, leaving portions of each representative unit and overall range-wide lacking resilient populations.

Future Conditions

In order to determine the future condition of the species, seven plausible scenarios were applied to project the impacts to the species or its habitat. The scenarios capture variation in the impacts from stressors and also variation in management intensity. Using the results from the habitat analysis, spatial analyses were used to predict changes in land cover and fire frequency under various levels of urbanization, sea level rise (SLR), and management effort. To capture the extent and rate of urbanization we used the Slope, Land cover, Exclusion, Urbanization, Transportation, and Hillshade (SLEUTH) model, which predicts the probability of urbanization ranging from 0-100%, with higher probabilities indicating areas more likely to be developed. Then, using the model framework developed for the current condition analysis, a stochastic simulation model was used that allowed us to project population persistence into the future as influenced by changes in habitat suitability and land protection, and we summarized predicted patterns of population persistence at 2040, 2060, and 2080. In order to capture the projected response of the species to the various factors included in each scenario, the probability of persistence of populations was considered at time steps of 2040, 2060 and 2080.

Table of Scenarios for Future Condition. List of scenarios used to predict future conditions for the southern hognose snake, showing levels of urbanization, sea level rise (SLR), and management conditions considered in each scenario. Note: SLR represents inundation levels at 2080.

Scenario Name	Urbanization	SLR	Management Level
Low Stressors	Low (90%)	Low (1ft)	Status Quo
Medium Stressors	Medium (50%) (most likely)	Medium (3ft) (most likely)	Status Quo

High Stressors	High (10%)	High (6ft)	Status Quo
Decreased Management	Medium (50%) (most likely)	Medium (3ft) (most likely)	Decreased management effort on protected lands by decreasing fire frequency by 20% (One less burn every 5 years).
Improved Management	Medium (50%) (most likely)	Medium (3ft) (most likely)	Increased management on protected lands by increasing fire frequency by 20% (One extra burn every 5 years).
Protect More Populations	Medium (50%) (most likely)	Medium (3ft) (most likely)	Acquire, protect, and improve additional land within population boundaries for those populations that are very likely to currently persist (> 80% current persistence probability), but are not currently protected and improve mgmt. on all protected lands by increasing fire frequency by one extra burn every 5 years.
Protect Even More Populations	Medium (50%) (most likely)	Medium (3ft) (most likely)	Acquire, protect, and improve additional land within population boundaries for those populations that are more likely than not to persist (> 50% current persistence probability), but are not currently protected and improve mgmt. on all protected lands by increasing fire frequency by one extra burn every 5 years.

Habitat conditions used to predict future persistence varied slightly between scenarios. Specifically, there were similar reductions of land cover, fire frequency, and HSI due to projected urbanization and SLR across the low, medium, and high stressor scenarios. Across the stressor scenarios, the average population lost from 12% of its compatible land cover (under low stressor levels) to 16% (under high stressor levels). While some populations experienced no loss of land cover, others were predicted to lose the majority of compatible land cover due to urbanization and SLR. A few coastal populations experienced a "squeezing" effect where there is a loss of land cover from SLR on one side and loss due to urbanization on another. Among the four management scenarios, the percent change in land cover, fire frequency, and HSI increased from the decreased management scenario to the protect even more populations scenario. We note that populations were still predicted to experience some degree of compatible land cover loss for all management scenarios; however, the two scenarios where more populations were protected resulted in an increase in HSI for populations, on average.

For the southern hognose snake to maintain viability, it needs to have resilient populations that

are able to withstand stochastic events and maintain ecological and genetic diversity, which will help preserve the breadth of adaptive capacity, and hence, the evolutionary flexibility of the species. In addition, the populations need to be spread across its range in a way that reduces the chance that a catastrophic event may lead to the species extinction.

Our analysis shows that future resiliency, as measured by future population persistence, for the southern hognose snake is predicted to decline from current conditions under all scenarios. We considered a population to be highly resilient if it had a relatively high future population persistence probability. By 2040, only 3.6% of populations exhibit the highest degree of resiliency under the medium stressor scenario, which is the most likely scenario. By 2060, there are no populations that exhibit the highest degree of resiliency for any of the scenarios except the scenarios where management is improved for the species. By 2080, only 2 of 222 (0.9%) historical populations exhibit the highest degree of resiliency under the highest management effort scenario. The other persistence thresholds see some variability in the number of populations remaining; however, all categories see a decrease in the number of populations within them, and there is an increase in the number of populations that are likely to become extirpated.

Our analysis shows that future representation, as measured by the number and distribution of resilient populations (i.e., those above a certain persistence probability threshold) across representative units in the species' range, will also be reduced from current conditions. To have high representation the species must have multiple highly resilient populations located in each of the representative units, and those occupied units should span the latitudinal and longitudinal extent of historical populations. As described in the current conditions, the southern hognose snake has already been extirpated from two representative units. In the future, there is high risk of the species being extirpated from a third representative unit and moderate risk of reduced representation in a fourth unit. The remaining five representative units showed declines in the number of resilient populations, but the risk of the species becoming extirpated from any unit was low. There has been a loss of latitudinal and longitudinal variability within the range, as all of the populations at the northern and western extent of its range have been extirpated.

Our analysis shows that future redundancy, as measured by the number and distribution of resilient populations within representative units and across the range of the species, will be reduced from current conditions under all scenarios tested. To have high redundancy, the species needs to have multiple resilient populations within a representative unit and throughout its range. Under all scenarios we see a reduction in the number of resilient populations within each of the units, as well as across the range of the species. In the future, the number of resilient populations decreased the most under scenarios that included no additional management effort; however, scenarios including the protection and habitat management of additional populations were predicted to maintain more resilient populations on the landscape relative to other scenarios. Additionally, the distribution of resilient

populations within each of the units and across the range will become increasingly clustered as additional populations become extirpated, leaving more portions of the range lacking resilient populations.

Our assessment shows that there have been range-wide declines for this species from its historical to current conditions, which has previously been suggested in the literature. The number of resilient populations is expected to continue to decrease in the future due to the effects of urbanization and SLR. Certain management efforts (i.e., acquiring, protecting, and managing land currently occupied by the species) may lessen the rate of population declines, but the southern hognose snake's resiliency, representation, and redundancy is expected to continue to decrease in the future.

SUMMARY OF THREATS

The primary threats to the southern hognose snake include habitat loss, conversion, fragmentation; fire suppression; timber harvesting; conversion of land to agriculture; urbanization; road mortality; climate change; persecution, harassment, and collection for the pet trade; and invasive species. The most significant threat for the long-term persistence of southern hognose snake is loss, conversion, and fragmentation of the longleaf pine ecosystem. Habitat has been lost historically and is expected to continue to be lost or converted into the future. However, the southern hognose snake currently occupies much of its historical range, and is expected to in the future, albeit with fewer populations persisting than current conditions. Although invasive species, such as red imported fire ants and feral hogs, persecution, over-collection for the pet trade, harassment, road mortality and disease may play a role in the species' viability, the degree of impact of these stressors to southern hognose snake populations across the species' range is uncertain.

The primary concerns for the southern hognose snake's status are habitat based. Habitat loss is due to a number of factors including fire suppression, timber harvesting, SLR, conversion of land to agriculture, and urbanization. The current constraints on the ability to manage longleaf pine habitat through prescribed fire are further exacerbated by urbanization and climate change.

It is likely that several of these factors are acting synergistically to impact the southern hognose snake, and the combination of multiple stressors may be more harmful than a single factor alone. There is some inherent uncertainty surrounding the stressors evaluated and their synergistic effects, but this does not prevent us from making a credible assessment of the likely direction and magnitude of those impacts though it may not be possible to make such predictions of impacts with precision.

Projections of habitat loss due to urban development and climate change were carried forward in our assessment of southern hognose snake populations and the overall viability of the species. We were not able to assess impacts from invasive species, such as red imported fire

ants and feral hogs, persecution, over-collection for the pet trade and increased harassment, and disease because datasets and or other information sources do not exist that capture the extent and degree of impact of these stressors to southern hognose snake populations across the species' range.

FINDING

After evaluating threats to the species under the section 4(a)(1) factors, we find that listing the southern hognose snake is not warranted. While resilience may be reduced into the future, primarily due to loss of high quality and quantity habitat, extinction is not likely now, given the current redundancy and representation that supports presence in the variety of ecoregions it currently occupies. Historically there were 222 known populations occurring across the 9 representative units. The species is difficult to detect and most records of occurrence come from observations of the species found Dead on Roads (DOR). Due to little to no available information to evaluate population abundance, the probability of persistence was used in the analysis, which indicates the species has experienced a reduction in its historic range and some loss of representation. In the northeastern and western portions of the range, populations in 2 representative units (West and Alabama Central) are considered extirpated as well as populations in the northeastern edge of range in the Atlantic Coastal Plain in North Carolina. Despite loss of populations and range reduction affecting the species, populations persist across much of its historic range. Out of the historic 222 populations, 89 are more likely than not to be currently persisting (>50% probability) and 49 populations are at or above the 95% persistence threshold. 133 populations rangewide are likely extirpated (60%). However, 40 percent of known populations are more likely than not (>50% probability) to remain on the landscape and 30 percent are considered very likely to remain on the landscape (>80% probability), demonstrating a fairly high level of resilience. For redundancy, the species is currently represented with greater than 2 populations in six out of nine representative units. The remaining resilient populations across the range of the representative units indicate the species has remained viable across much of its historic range. As such, the species is not currently in danger of extinction such that it meets the definition of an endangered species.

When considering the threats to the species and the scenarios used in the analysis, in order to determine if the species meets the definition of a threatened species, the foreseeable future that was used was 30-40 years. This time frame was based on factors that influence the species now and the projections that determined the future condition of the species. The principal factors analyzed that influence the species' condition moving into the future were urbanization and SLR as they influence habitat loss/fragmentation and also management as it affects habitat quality. While urbanization and SLR models were projected out to 2080, beyond 30 – 40 years these projections become more speculative in nature. Similarly, due to uncertainty related to future funding/ability to protect (i.e., acquire) and manage populations on protected lands, projecting beyond this timeframe becomes speculative as well.

In order to determine if the southern hognose snake is a threatened species, or in danger of

extinction in the foreseeable future, the future condition of the species was considered. Based on the models used in the different scenarios, the species' viability is expected to continue to decline. In the next 20 to 40 years, redundancy is expected to decline as populations with >50% probability of persistence are expected to decrease from 89 populations to between 62 and 70 (depending on the scenario). Population resiliency is also expected to decline. Between years 2050 to 2060, populations with >80% probability of persistence are expected to decline from 68, currently, to 24 and 33 populations for worst case (decreased management) scenarios and 28 populations for the most likely scenario (medium stressor) based on the projected scenarios. Representation will remain the same with 7 of 9 representative units with populations; however, one of those will remain at risk of extirpation (Coastal Plain GA/FL). Resilient populations within each representative unit will become more clustered and isolated with more of the unit likely becoming unoccupied.

While the species is expected to decline and some populations are likely to become extirpated, the species is expected to retain viability with resilient populations across much of its current range. Despite loss of redundancy and representation across its current range, representation will remain relatively high with 7 out 9 representative units remaining occupied with multiple populations (80% probability of persistence). Redundancy and representation declines from current conditions; however, the southern hognose snake is expected to remain viable into the foreseeable future. After considering the condition of the species into the foreseeable future based on various levels of stressors acting on the species and management actions, we have determined the southern hognose snake is not in danger of extinction within the foreseeable future. Therefore it is not likely to become an endangered species in the foreseeable future such that it meets the definition of a threatened species.

Significant Portion of the Range Analysis

Determination of Status Throughout a Significant Portion of Its Range

Under the Act and our implementing regulations, a species may warrant listing if it is in danger of extinction or likely to become so in the foreseeable future throughout all or a significant portion of its range (SPR). Where the best available information allows the Services to determine a status for the species rangewide, that determination should be given conclusive weight because a rangewide determination of status more accurately reflects the species' degree of imperilment and better promotes the purposes of the Act. Under this reading, we should first consider whether the species warrants listing "throughout all" of its range and proceed to conduct a "significant portion of its range" analysis if, and only if, a species does not qualify for listing as either an endangered or a threatened species according to the "throughout all" language.

Having determined that the southern hognose snake is not in danger of extinction or likely to become so in the foreseeable future throughout all of its range, we now consider whether it

may be in danger of extinction or likely to become so in the foreseeable future in an SPR. The range of a species can theoretically be divided into portions in an infinite number of ways, so we first screen the potential portions of the species' range to determine if there are any portions that warrant further consideration. To do the "screening" analysis, we ask whether there are portions of the species' range for which there is substantial information indicating that: (1) the portion may be significant; and, (2) the species may be, in that portion, either in danger of extinction or likely to become so in the foreseeable future. For a particular portion, if we cannot answer both questions in the affirmative, then that portion does not warrant further consideration and the species does not warrant listing because of its status in that portion of its range. We emphasize that answering these questions in the affirmative is not a determination that the species is in danger of extinction or likely to become so in the foreseeable future throughout a significant portion of its range—rather, it is a step in determining whether a more detailed analysis of the issue is required.

If we answer these questions in the affirmative, we then conduct a more thorough analysis to determine whether the portion does indeed meet both of the SPR prongs: (1) the portion is significant and (2) the species is, in that portion, either in danger of extinction or likely to become so in the foreseeable future. Confirmation that a portion does indeed meet one of these prongs does not create a presumption, prejudgment, or other determination as to whether the species is an endangered species or threatened species. Rather, we must then undertake a more detailed analysis of the other prong to make that determination. Only if the portion does indeed meet both SPR prongs would the species warrant listing because of its status in a significant portion of its range.

At both stages in this process—the stage of screening potential portions to identify any portions that warrant further consideration and the stage of undertaking the more detailed analysis of any portions that do warrant further consideration—it might be more efficient for us to address the "significance" question or the "status" question first. Our selection of which question to address first for a particular portion depends on the biology of the species, its range, and the threats it faces. Regardless of which question we address first, if we reach a negative answer with respect to the first question that we address, we do not need to evaluate the second question for that portion of the species' range.

For the southern hognose snake, we chose to evaluate the status question (i.e., identifying portions where the southern hognose snake may be in danger of extinction or likely to become so in the foreseeable future) first. To conduct this screening, we considered whether the threats are geographically concentrated in any portion of the species' range at a biologically meaningful scale. We examined the following threats: habitat loss, conversion, and fragmentation; road mortality; invasive species; the effects of climate change; persecution, harassment, and the pet trade; and disease, including cumulative effects. We found no concentration of threats in any portion of the southern hognose snake range at a biologically meaningful scale.

If both (1) a species is not in danger of extinction or likely to become so in the foreseeable future throughout all of its range and (2) the threats to the species are essentially uniform throughout its range, then the species could not be in danger of extinction or likely to become so in the foreseeable future in any biologically meaningful portion of its range. For the southern hognose snake, we found both: the species is not in danger of extinction or likely to become so in the foreseeable future throughout all of its range, and there is no geographical concentration of threats so the threats to the species are essentially uniform throughout its range. Therefore, no portions warrant further consideration through a more detailed analysis, and the species is not in danger of extinction or likely to become so in the foreseeable future in any significant portion of its range. Our approach to analyzing SPR in this determination is consistent with the court's holding in *Desert Survivors v. Department of the Interior*, No. 16-cv-01165-JCS, 2018 WL 4053447 (N.D. Cal. Aug. 24, 2018).

Our review of the best available scientific and commercial information indicates that the southern hognose snake is not in danger of extinction or likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. Therefore, we find that listing the southern hognose snake as an endangered species or a threatened species under the Act is not warranted at this time.

BATCHED NOTICE LANGUAGE

The southern hognose snake is the smallest of the hognose snakes and is associated with xeric longleaf pine savannah, flatwoods, and sandhills from southeastern North Carolina, South Carolina, Georgia, Florida, and west to Alabama and Mississippi. They occupy upland habitat with well-drained, sandy soils, characterized by pine-dominated or pine-oak woodland where the canopy is open with a grassy understory. Specific ecological needs that are essential to the survival and reproductive success of individuals include well-drained soils, suitable vegetation structure and composition, and presence of prey.

The potential factors that could be affecting the viability of the southern hognose snake include the following: (1) habitat loss, conversion, and fragmentation from loss of longleaf pine savanna habitat; (2) road mortality; (3) invasive species, such as the red imported fire ant and feral hogs; (4) effects of climate change resulting in increased temperatures, decreased precipitation, increased severe weather such as drought, flooding, or storms, changes in wildfire frequency and intensity, decreased ability to conduct prescribed burns, and sea level rise (SLR); (5) the collection of individual snakes for the pet trade and persecution by humans; and (6) impacts that a potential disease outbreak, such as snake fungal disease may have on existing populations.

Our review of the best available scientific and commercial information indicates that the southern hognose snake is not in danger of extinction or likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Therefore, we find that listing the southern hognose snake as an endangered species or a threatened species under the Act is not warranted at this time.

RECOMMENDED CONSERVATION MEASURES

While the species does not currently warrant listing per the Endangered Species Act, the species has been declining. In order to protect the species from unsustainable loss of viability in the future, certain conservation measures have been recommended.

- Continue habitat management, conservation agreements and purchase of lands
  - Appropriate fire management benefits the species
  - Maintain contiguous parcels to ensure connectivity for genetic integrity
- Conduct standardized surveys across the species' range
- New information
- Consider road closures where possible during peak breeding and dispersal seasons
- Conduct outreach to inform the public about the benefit of the species in the wild in order to reduce impacts from harassment, persecution and collection for the pet trade.

DESCRIPTION OF MONITORING

Ongoing monitoring of the species has occurred by States within the species' range. The future of any monitoring is uncertain; however, the species would benefit from continued monitoring in order to better understand the species.

We request that any new information concerning the status of, or threats to, the southern hognose snake be submitted to our South Carolina Ecological Services Field Office (see ADDRESSES section of the Federal Register Notice for the 12-month finding) whenever it becomes available. New information will help us monitor this species and encourage its conservation. If an emergency situation develops for the species, we will act to provide immediate protection.

COORDINATION WITH STATES

All states across the species' range were contacted prior to or during the development of the species status assessment; these include North Carolina, South Carolina, Georgia, Florida, Alabama and Mississippi.

Native American Tribes were also contacted at the initiation of the species status assessment including Catawba Indian Nation, Eastern Band of Cherokee Indians, Miccosukee Tribe of Indians, Poarch Band of Creek Indians, Mississippi Band of Choctaw Indians, and Seminole Tribe of Florida.

LITERATURE CITED

U.S. Fish and Wildlife Service. 2019. Species status assessment report for the southern hognose snake (*Heterodon simus*), Version 1.1. April 2019. Atlanta, GA.

*For all other references, please see the "References Cited" section of the Species Report (Service 2019).

APPROVAL/CONCURRENCE: Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes, including elevations or removals from candidate status and listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all resubmitted 12-month petition findings, additions or removal of species from candidate status, and listing priority changes.

Approve: _____ 7/12/19
Regional Director, Fish and Wildlife Service — Date

Concur: _____ 9-16-19
Principal Deputy Director, U.S. Fish and Wildlife Service,
Exercising the Authority of the Director, U.S. Fish and Wildlife Service — Date

Do not concur: _____
Principal Deputy Director, U.S. Fish and Wildlife Service,
Exercising the Authority of the Director, U.S. Fish and Wildlife Service — Date

Director's Remarks:

Date of annual review:
Conducted by: