Florida Pine Snake Biological Status Review Report

March 31, 2011

FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION
620 South Meridian Street
Tallahassee, Florida 32399-1600

Biological Status Review Report
for the
Florida Pine Snake
(*Pituophis melanoleucus mugitus*)
March 31, 2011

EXECUTIVE SUMMARY

The Florida Fish and Wildlife Conservation Commission (FWC) directed staff to evaluate all species listed as Threatened or Species of Special Concern as of November 8, 2010 that had not undergone a status review in the past decade. Public information on the status of the Florida pine snake was sought from September 17 through November 8, 2010, but no information was received. The 5-member Biological Review Group (BRG) met on November 18, 2010. Group members were Kevin Enge (FWC lead), Steve Johnson (University of Florida), Richard Owen (Florida Department of Environmental Protection), Thomas Ostertag (FWC), and David Printiss (The Nature Conservancy) (Appendix 1). In accordance with rule 68A-27.0012, Florida Administrative Code (F.A.C.), the BRG was charged with evaluating the biological status of the Florida pine snake using criteria included in definitions in 68A-27.001, F.A.C., and following protocols in the *Guidelines for Application of the IUCN Red List Criteria at Regional Levels (Version 3.0)* and *Guidelines for Using the IUCN Red List Categories and Criteria (Version 8.1)*. Please visit http://myfwc.com/wildlifehabitats/imperiled/listing-action-petitions/ to view the listing process rule and the criteria found in the definitions.

In late 2010, staff developed the initial draft of this report which included BRG findings and a preliminary listing recommendation from staff. The draft was sent out for peer review and the reviewers' input has been incorporated to create this final report. The draft report, peer reviews, and information received from the public are available as supplemental materials at http://myfwc.com/wildlifehabitats/imperiled/biological-status/.

The BRG concluded that the Florida pine snake met at least one listing criterion (a population size reduction of at least 30% projected or suspected to be met within the next 3 generations). The BRG projected a population size reduction of at least 30% in Florida pine snake populations within the next 3 generations (24 years) based upon: a projected 32% increase in Florida's human population by 2035, only 24% of the pine snake's potential habitat being on public conservation lands, altered fire regimes on public and private lands, a continuing backlog of fire-suppressed habitats, suspected population declines in pocket gopher populations, and the species' susceptibility to habitat fragmentation and residential development (i.e., mortality from vehicles, landowners, and pets). After careful consideration and deliberation, FWC staff did not agree that the information supported a 30% projected decline in Florida pine snake populations over the next 24 years and, in the earlier draft of this report, recommended the Florida pine snake not be listed as a Threatened species. However, only 1 of 4 peer reviewers agreed with the staff recommendation to delist the species. Taking into account the BRG findings, peer reviews, and the uncertainty involved in projecting a population size reduction, FWC staff recommends that the Florida pine snake be listed as a Threatened species.

This work was supported by a Conserve Wildlife Tag grant from the Wildlife Foundation of Florida. FWC staff gratefully acknowledges the assistance of the biological review group members and peer reviewers. Staff would also like to thank Dr. Joseph Mitchell who served as a data compiler for the species.

BIOLOGICAL INFORMATION

Taxonomic Classification – The Florida pine snake (*Pituophis melanoleucus mugitus* Barbour, 1921) is 1 of 3 currently recognized subspecies of the pine snake (Crother 2008). It intergrades with the black pine snake (*P. m. lodingi*) in Escambia County, Florida (Mount 1975, Franz 1992).

Life History and Habitat Requirements – Information on the Florida pine snake has been summarized by Franz (1992), Ernst and Ernst (2003), Franz (2005), and Miller (2008). The Florida pine snake prefers habitats with well-drained, sandy soils and moderate to open canopy cover (Franz 1992, Ernst and Ernst 2003). The most common natural habitat of pine snakes in Florida is sandhill, but they also are found in scrub, xeric hammock, scrubby flatwoods, and mesic pine flatwoods and dry prairie with dry soils (Allen and Neill 1952, Enge 1997, Franz 2005). During a telemetry study in northern peninsular Florida, 69% of observations were in sandhill (i.e., high pine), followed by ruderal habitats (i.e., pastures, former orange groves, and old hay fields), xeric hammock, and lake edge (Franz 2005). During a telemetry study in southwestern Georgia, pine snakes used habitats relative to their availability within their home ranges, but at a landscape level, they had a significant preference for mixed pine-hardwood forests, whereas all other habitats (i.e., pine regeneration plots and plantations, scrub/shrub or fallow land, agricultural fields or wildlife food plots, urban areas, hardwood forest, natural pine forest, and aquatic habitat) were used relative to their availability (Miller 2008). Florida pine snakes are fossorial, spending ca. 80% of their time in underground retreats, primarily burrows of the southeastern pocket gopher (*Geomys pinetis*) (Franz 2005, Miller 2008). Other retreats used are stumpholes, mole runs, and burrows of gopher tortoises (*Gopherus polyphemus*), nine-banded armadillos (*Dasypus novemcinctus*), and mice (Franz 2005, Miller 2008). Florida pine snakes are diurnally active and occasionally climb into shrubs and small trees (Franz 2005). Pine snakes primarily feed on pocket gophers, other rodents, and rabbits, but they also eat ground-dwelling birds and eggs (Allen and Neill 1952, Ernst and Ernst 2003, Franz 2005, Miller 2008). Pine snakes are adept at excavating the sand plugs of pocket gopher burrows to access their runways (Franz 2001, 2005). The pine snake lays an average of 8.7 eggs (n = 111) (Ernst and Ernst 2003), but 4 clutches of the Florida subspecies ranged from 4 to 8 eggs (mean 5.6) (Neill 1951, Franz 2005). Mammals, birds, and snakes have been reported preying upon pine snakes, primarily smaller individuals, and their eggs (Ernst and Ernst 2003).

Population Status and Trend – Carr (1940) considered the Florida pine snake to be "not common." Franz (1992) claimed that some herpetologists thought that pine snakes had seriously declined in the last 20 years. However, there are no quantitative studies of population trends for this species. At the Ordway-Swisher Biological Station in Putnam County, more than 16 adult snakes were found between 1983 and 1991 but only 4 snakes since then, suggesting a major decline in the population that was possibly related to 2 severe regional droughts (Franz 2005). Of 464 records from museums, Florida Natural Areas Inventory (FNAI), and the literature, 105

records were from the 1990s and 64 from the 2000s. Pine snakes are probably more common than observational data suggest because of their highly fossorial habits (Franz 2005). If enough time is spent in the field or driving roads in suitable habitat, pine snakes are often detected. For example, there are 20 pine snake records from Eglin Air Force Base in 1993–98, mostly from persons involved in surveys for rare species (Printiss and Hipes 1999).

Geographic Range and Distribution – The Florida pine snake is associated with the Coastal Plain physiographic region, occurring in the extreme southeastern United States from southwestern South Carolina southwestward to Mobile Bay in southern Alabama, and south into Florida, excluding the Everglades (Conant and Collins 1991, Ernst and Ernst 2003). There are few records south of the southern end of Lake Okeechobee (Fig. 1).

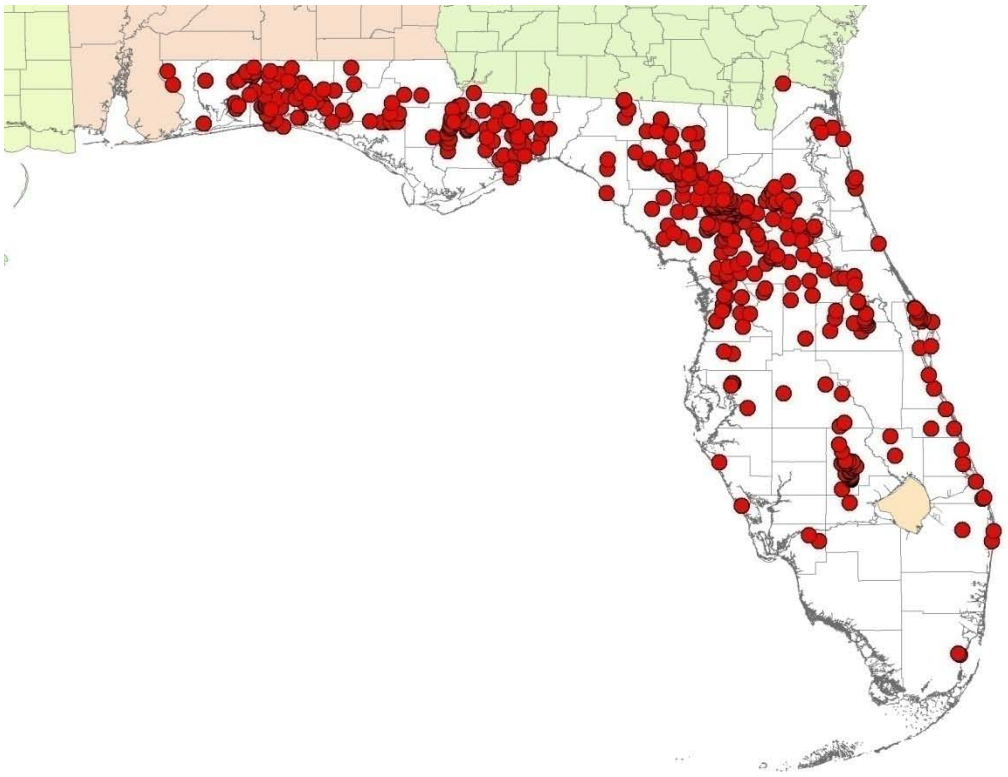

Fig. 1. Locality records from museums, FNAI, and the literature for the Florida pine snake in Florida.

Quantitative Analyses – Two population viability analysis models have been run for the Florida pine snake in Florida (Root and Barnes 2005). One model considered all potential habitat identified and the other model only potential habitat occurring on conservation lands. Under the baseline parameters, there was 0% risk of extinction or 20% population decline over the next 100 years for both models. The initial abundance was set at a conservative 0.2 individuals/ha, and a distance of 1.2 km was set to identify discrete populations, producing 495 populations for the conservation lands model and 343 populations for the all potential habitat model. The conservation lands model had more populations because populations were fragmented by property boundaries instead of being connected by habitat on private lands.

Juvenile survival was set at 50% and adult survival at 65%. Fecundity for adults was set at 0.83, which is one-half of the average clutch size (5.6 eggs), multiplied by 85% of the female population breeding annually, and multiplied by a 35% survival rate of eggs to Year 1. This information produced a population growth rate of 1.0465.

BIOLOGICAL STATUS ASSESSMENT

Threats – Enge et al. (2003) provided descriptions of sandhill habitat and threats to its wildlife community. By 1987, 88% of Florida's sandhill habitat had been lost (Kautz et al. 1993), and scrub habitat has also experienced serious losses (Enge et al. 2003). It is estimated that >97% of the original longleaf pine (*Pinus palustris*) ecosystem has been converted to agriculture, pine plantations, and urban areas (Noss et al. 1995). From 1985–89 to 2003, 15.5% of Florida's sandhill habitat, 12.4% of its scrub habitat, and 9.2% of its pinelands were converted to other uses, primarily urban or other developed uses (Kautz et al. 2007). Shrub and brushland, a semi-natural cover type often used by pine snakes, lost 36.3% of its acreage to intensive human uses (Kautz et al. 2007). Franz (1992) suspected population declines in the Florida pine snake were due to excessive collecting, road mortality, and habitat loss. In New Jersey, the 6 greatest threats to northern pine snakes (*P. m. melanoleucus*) were identified as habitat loss and fragmentation, illegal collection, predation from natural and subsidized predators, road mortality, fire suppression and habitat change, and off-road vehicle use (Golden et al. 2009). The greatest threat to pine snakes in Florida is probably habitat loss and fragmentation resulting from commercial and residential development, silviculture, agriculture, mining, and roads. Longleaf pine-dominated sandhill as well as scrub habitat on the ridges of central Florida and along both coasts have suffered serious losses (Means and Grow 1985, Myers 1990, Kautz 1998, Enge et al. 2003). Pine snakes once occurred along the Atlantic Coastal Ridge as far south as Miami (Duellman and Schwartz 1958, Florida Museum of Natural History record from 1980), but urban development in southeastern Florida has eliminated some of these populations. There are no recent museum or FNAI records south of Martin County, but the species apparently still occurs in Palm Beach County (D. Parker, Sunshine Serpents, pers. commun. 2011). Altered fire regimes in sandhill habitat and resulting hardwood encroachment presumably create less favorable habitat conditions for pine snakes, although they will use xeric hammocks. Presumably, pine snakes do poorly in dense pine plantations, particularly sand pine (*Pinus clausa*) plantations on former sandhill sites in the Panhandle. Pine snake populations can coexist with some agricultural development, and snakes may thrive in abandoned fields. Stumpwood removal may affect pine snake subpopulations by decreasing underground habitat structure (Means 2005); this may be particularly detrimental in areas where pocket gophers are absent.

Pine snakes are large and conspicuous, and populations in subdivisions are threatened by road mortality and killing by residents and domestic pets (Jordan 1998). Large, slow-moving snakes are highly susceptible to road mortality (Andrews and Gibbons 2005); in eastern Texas, populations of large snakes were 50% less abundant up to 450 m from roads than they were 850 m from roads (Rudolph et al. 1999). Florida pine snakes may avoid crossing major highways abutting their home ranges (Miller 2008), and data using the random path generator in ArcGIS versus actual snake movements suggest that pine snakes cross paved roads and wide, graded roads significantly less than expected; anecdotal evidence suggests that road-crossing potential may increase in small, fragmented habitat patches or where more roads occur (G. Miller, Department of Land and Environment, pers. commun. 2011). Paved roads, sand roads, and trails

are prevalent on most federal and state lands, making pine snakes susceptible to mortality from off-road vehicles and other human use of these areas (R. Zappalorti, Herpetological Associates, pers. commun. 2011). Because of their association with pocket gophers, pine snake populations might be expected to decline in response to declines in pocket gopher populations, such as from pest control programs. Pocket gopher populations have apparently declined in Alabama, Georgia, and to a lesser extent, Florida (Georgia Department of Natural Resources 2008, Miller et al. 2008); a subspecies of pocket gopher in Florida is now extinct (Humphrey 1992). However, Florida pine snake populations occur in areas where pocket gophers are absent. Pine snakes might be experiencing increased rates of predation of adults, hatchlings, or eggs from subsidized mammalian predators, nine-banded armadillos (*Dasypus novemcinctus*), feral hogs (*Sus scrofa*), domestic cats and dogs, and red imported fire ants (*Solenopsis invicta*) (R. Zappalorti, Herpetological Associates, pers. commun. 2011). Collection of pine snakes for pets presumably decreased when they were listed as a Species of Special Concern; commercialization was prohibited and a personal possession limit of one snake was imposed. Later, commercialization was permitted for "albino" (i.e., amelanistic and leucistic) individuals. If collection and commercialization of normal-looking specimens were permitted again, the threat to wild populations would be unknown. Florida pine snakes cannot be collected in large quantities because of their fossorial nature and dispersed distribution. Unlike northern pine snakes, which are threatened by illegal collection in New Jersey (Golden et al. 2009), Florida pine snakes do not have communal hibernacula and oviposition sites. Plus, there is less demand for the less vividly marked Florida subspecies, although there is a market for amelanistic, leucistic, and patternless specimens (K. Enge, FWC, pers. commun. 2010).

Population Assessment – Findings from the BRG are included in Biological Status Review Information Findings tables. The BRG concluded that the Florida pine snake met Sub-criterion A3 (a population size reduction of at least 30% projected or suspected to be met within the next 3 generations). The BRG projected a population size reduction of at least 30% within the next 3 generations (24 years) based upon: a projected 32% increase in Florida's human population by 2035, only 24% of the pine snake's potential habitat being on public conservation lands, altered fire regimes on public and private lands, a continuing backlog of fire-suppressed habitats, suspected population declines in pocket gopher populations, and the species' susceptibility to habitat fragmentation and residential development (i.e., mortality from vehicles, landowners, and pets).

LISTING RECOMMENDATION

FWC staff, including herpetologists and fire management experts, carefully considered the BRG's findings and assumptions for criterion A3 and could not project a 30% decline in Florida pine snakes in the next 24 years. Staff considered the fact that initial projections of increases in Florida's human population by Zwick and Carr (2006) have not been met. Staff expects the future human population growth rate to be lower than initially projected as well. Although loss and fragmentation of pine snake habitat from human population increases can reasonably be expected to cause declines in pine snake populations, there are insufficient data to predict the magnitude of the decline. Staff believes that the backlog of fire-suppressed pine snake habitat is not as severe as assumed by the BRG. Staff's interpretation of the State of Florida Land Management Uniform Accounting Council (2010) report on the number of acres

reported burned in the appropriate fire return interval is different than what the BRG concluded. For example, 54% of all state-managed lands and 86% of FWC-managed lands were within the fire return interval in 2009-10. There are likely other similar examples for other land management agencies. Considering all this information, staff does not project a 30% decline in Florida pine snake populations in the next 24 years (3 generations), although some lower level of decline will probably occur. Because of these considerations, staff initially recommended that the Florida pine snake not be listed as a Threatened species. However, after receiving the peer reviews, staff reassessed its recommendation. Because of uncertainty regarding future human population growth rates, future habitat conditions on public conservation lands, future status of suitable private lands (which presently contain 76% of the identified potential habitat), present status of pine snake populations, and responses of pine snake populations to habitat degradation and fragmentation, staff now feels that the precautionary principle should be applied and the Florida pine snake should be listed as a Threatened species until sufficient data are obtained on its population status.

SUMMARY OF THE INDEPENDENT REVIEW

Comments were received from 4 reviewers: Mr. Dirk Stevenson (independent consultant), Mr. Robert T. Zappalorti (Herpetological Associates, Inc.), Mr. Gabriel J. Miller (Department of Land and Environment, Prairie Island Indian Community), and Dr. Lora L. Smith (Joseph W. Jones Ecological Research Center). Appropriate editorial changes recommended by the reviewers were made to the report. One reviewer agreed with the staff recommendation to delist the species, and the other 3 reviewers disagreed and thought the species should be listed as Threatened or Species of Special Concern (SSC). One reviewer thought the species should remain listed as SSC until data are obtained on the magnitude of population decline. Another reviewer thought the species should remain listed as Threatened (it is presently SSC, not Threatened) because the projected population decline in 3 generations was based upon dubious numbers and speculation. Both of these dissenting reviewers questioned whether land management funds will remain stable in the light of projected state and federal budget shortfalls, leading to a future increase in acreage of fire-suppressed habitats. The reviewer in favor of Threatened status argued that the slowed rate of human population growth may increase in the near future in response to an economic upturn or other factors, and he argued that the precautionary principle should be applied until sufficient data are obtained on its population status.

The third dissenting reviewer thought the species should remain listed as SSC and presented personal observations regarding its status. This reviewer thought the species had experienced population declines in the past 15 years in some highly developed areas and disturbed habitat types, particularly in the Tallahassee−Jacksonville region, Gainesville−Ocala region, and the Lake Wales Ridge. In >2,500 person hours in 2004−10 on the Citrus Tract of Withlacoochee State Forest, 31 eastern indigo snakes (*Drymarchon couperi*) or their sign were found, primarily near gopher tortoise burrows and stumpholes, and only 3 Florida pine snakes. Staff considers this comparison of relative abundance between the 2 species to be invalid because the pine snake spends more time underground, and it is more often associated with pocket gopher burrows (when present) than the retreats targeted for searching by the reviewer. Searches on cool, sunny days near pocket gopher mounds in sandhill and oldfield habitats on the

northern portion of the Brooksville Ridge yield pine snakes on a regular basis (R. Ashton, pers. commun. 2009; A. Flanagan, pers. commun. 2010; D. Parker, pers. commun. 2011). At a site near the Gainesville Regional Airport, 1−5 pine snakes were found during each visit in 2010 (M. Kail, Santa Fe College, pers. commun. 2011). During the past 23 years, the reviewer and associates spent an average of 1−2 weeks per year conducting herpetofaunal surveys in Apalachicola National Forest, Tate's Hell State Forest, and Apalachicola Bluffs and Ravines Preserve but found only 2 live pine snakes, 3 road-killed snakes, and 1 shed skin. The reviewer questioned why large upland forest areas like Apalachicola National Forest, Tate's Hell State Forest, Osceola National Forest, and portions of Ocala National Forest appear to have minimal Florida pine snake populations despite management by prescribed burning, suitable forest types and habitat structure, ample prey resources, and limited fragmentation by roads. Staff considers the relative scarcity of pine snakes on Apalachicola and Osceola national forests and Tate's Hell State Forest to be the result of a predominance of poorly drained habitats, primarily pine flatwoods, that are marginal or unsuitable for pine snakes. In addition, Tate's Hell State Forest had a long history of intensive silviculture before being purchased by the State, and the national forests have been commercially stumped several times. Pine snakes are reasonably abundant in the more xeric portions of Apalachicola National Forest (T. Ostertag, FWC, pers. commun. 2010). In the database of 464 pine snake records compiled by the BRG, 22 records came from Apalachicola National Forest, and all 3 counties within the forest had at least 6 records, including at least 1 record within the past 6 years. Most of Ocala National Forest consists of sand pine scrub, which provides marginal habitat for pine snakes because of limited prey and refugia (K. Enge, FWC, pers. commun. 2011). There are pine snake records from all 3 counties within Ocala National Forest. This reviewer suggested a noticeable population decline was evidenced by 105 literature, museum, and FNAI records from the 1990s and only 64 from the 2000s. Staff feels these observations do not necessarily reflect population trends because many factors besides actual abundance contribute to differences in numbers of records among decades. Since the Biological Status Review draft was submitted for independent review, an unpublished report was found that had 16 additional observations of the Florida pine snake in Blackwater State Forest in 2006 (*see* Lorenz and Yates 2006).

One reviewer questioned the validity of the 2 population viability analysis models because some of the parameters used differed from those obtained during studies of the northern pine snake in New Jersey. Staff feels that differences in the habits, life history, and climate of these 2 subspecies make some parameter comparisons invalid. Another reviewer cautioned that the use of best-guess numbers, even conservative ones, instead of actual data may lead to a false conclusion regarding true survivorship. Staff feels that loss, degradation, and fragmentation of pine snake habitat from human population increases and possibly inadequate habitat management can reasonably be expected to cause future declines in pine snake populations, but insufficient data exist to predict the magnitude of the decline. Consequently, staff recommends that the precautionary principle be applied and the Florida pine snake be listed as a Threatened species until sufficient data are obtained on its population status. The reviews can be found at MyFWC.com.

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Biological Status Review Information
Findings

Species/taxon: Florida Pine Snake
Date: 11/18/10
Assessors: Enge, Johnson, Ostertag, Printiss, Owen

Generation length: 8 years

Criterion/Listing Measure	Data/Information	Data Type*	Sub-Criterion Met?	References
*Data Types - observed (O), estimated (E), inferred (I), suspected (S), or projected (P). Sub-Criterion met - yes (Y) or no (N).				
(A) Population Size Reduction, ANY of				
(a)1. An observed, estimated, inferred or suspected population size reduction of at least 50% over the last 10 years or 3 generations, whichever is longer, where the causes of the reduction are clearly reversible and understood and ceased[1]		S	N	Franz (2005), Kautz et al. (2007)
(a)2. An observed, estimated, inferred or suspected population size reduction of at least 30% over the last 10 years or 3 generations, whichever is longer, where the reduction or its causes may not have ceased or may not be understood or may not be reversible[1]	<30% population size reduction because only 23.5% increase in human population since 1990 and acquisition of conservation lands. From 1985–89 to 2003, 15.5% of sandhill, 12.4% of scrub, 9.2% of pinelands, 36.3% of shrub and brushland, 11.3% of upland forest, 25.4% of dry prairie, and 10.8% of coastal strand were converted to other land uses, often urban or other developed uses.	S	N	Franz (2005), Kautz et al. (2007), U.S. Census Bureau
(a)3. A population size reduction of at least 30% projected or suspected to be met within the next 10 years or 3 generations, whichever is longer (up to a maximum of 100 years) [1]	Florida's population is projected to increase by 31.7% in the next 25 years, but this won't necessarily result in an equivalent destruction of pine snake habitat. However, only 24% of the potential habitat is in conservation lands, and upland habitats favored by this species are particularly in demand for development. This is a large-bodied species with a relatively large home range whose subpopulations decline in response to habitat fragmentation and residential development, suffering mortality from vehicles, landowners, and pets. Continued altered fire regimes (timing, intensity, fire-return interval, and season) and lack of fire management on public and private lands will likely result in future population declines. Suspected declines in pocket gopher populations will probably continue, affecting those pine snake subpopulations that rely on pocket gophers for underground retreats and food.	S	Y	Rudolph et al. (1999), Andrews and Gibbons (2005), Zwick and Carr (2006); Miller et al. (2008); State of Florida Land Management Uniform Accounting Council (2010); D. Printiss and R. Owen, pers. commun.; GIS analysis of potential habitat by B. Stys (FWC)

(a)4. An observed, estimated, inferred, projected or suspected population size reduction of at least 30% over any 10 year or 3 generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased or may not be understood or may not be reversible.[1]	<30% population size reduction (see A2 and A3)	S	N	Zwick and Carr (2006)
[1] based on (and specifying) any of the following: (a) direct observation; (b) an index of abundance appropriate to the taxon; (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat; (d) actual or potential levels of exploitation; (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.				
(B) Geographic Range, EITHER				
(b)1. Extent of occurrence < 20,000 km^2 (7,722 mi^2) OR	ca. 76,800 km^2 in 38 counties (since 1990)	E	N	
(b)2. Area of occupancy < 2,000 km^2 (772 mi^2)	19,984 km^2	E	N	GIS analysis of potential habitat by B. Stys (FWC)
AND at least 2 of the following:		S	N	
a. Severely fragmented or exist in ≤ 10 locations				
b. Continuing decline, observed, inferred or projected in any of the following: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent, and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals		P	Y	
c. Extreme fluctuations in any of the following: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals		S	N	
(C) Population Size and Trend				
Population size estimate to number fewer than 10,000 mature individuals AND EITHER	>30,000 mature individuals based on a mean home range size of 58 ha and the amount of potential habitat	S	N	Franz (2005), Miller (2008), GIS analysis of potential habitat by B. Stys (FWC)
(c)1. An estimated continuing decline of at least 10% in 10 years or 3 generations, whichever is longer (up to a maximum of 100 years in the future) OR		S	Y	See Sub-criterion A3
(c)2. A continuing decline, observed, projected, or inferred in numbers of mature individuals AND at least one of the following:		P	Y	See Sub-criterion A3
a. Population structure in the form of EITHER				
(i) No subpopulation estimated to contain more than 1000 mature individuals; OR		S	N	
(ii) All mature individuals are in one subpopulation		I	N	
b. Extreme fluctuations in number of mature		S	N	

individuals				
(D) Population Very Small or Restricted, EITHER				
(d)1. Population estimated to number fewer than 1,000 mature individuals; OR	>30,000 mature individuals	S	N	See Criterion C
(d)2. Population with a very restricted area of occupancy (typically less than 20 km^2 [8 mi^2]) or number of locations (typically 5 or fewer) such that it is prone to the effects of human activities or stochastic events within a short time period in an uncertain future	19,984 km^2	E	N	See Sub-criterion B2
(E) Quantitative Analyses				
e1. Showing the probability of extinction in the wild is at least 10% within 100 years	0% risk of extinction within 100 years	E	N	Root and Barnes (2005)

Initial Finding (Meets at least one of the criteria OR Does not meet any of the criteria)	Reason (which criteria/sub-criteria are met)
Threatened	A3
Is species/taxon endemic to Florida? (Y/N)	
If Yes, your initial finding is your final finding. Copy the initial finding and reason to the final finding space below. If No, complete the regional assessment sheet and copy the final finding from that sheet to the space below.	
Final Finding (Meets at least one of the criteria OR Does not meet any of the criteria)	Reason (which criteria/sub-criteria are met)
Threatened	A3

1	Species/taxon:	Florida Pine Snake
2	Date:	11/18/10
3	Assessors:	Enge, Johnson,Ostertag, Owen, Printiss
4		
5		
6		
7		
8	Initial finding	
9		
10	2a. Is the species/taxon a non-breeding visitor? (Y/N/DK). If 2a is YES, go to line 18. If 2a is NO or DO NOT KNOW, go to line 11.	No
11	2b. Does the Florida population experience any significant immigration of propagules capable of reproducing in Florida? (Y/N/DK). If 2b is YES, go to line 12. If 2b is NO or DO NOT KNOW, go to line 17.	No
12	2c. Is the immigration expected to decrease? (Y/N/DK). If 2c is YES or DO NOT KNOW, go to line 13. If 2c is NO go to line 16.	
13	2d. Is the regional population a sink? (Y/N/DK). If 2d is YES, go to line 14. If 2d is NO or DO NOT KNOW, go to line 15.	
14	If 2d is YES - Upgrade from initial finding (more imperiled)	
15	If 2d is NO or DO NOT KNOW - No change from initial finding	
16	If 2c is NO or DO NOT KNOW- Downgrade from initial finding (less imperiled)	
17	If 2b is NO or DO NOT KNOW - No change from initial finding	
18	2e. Are the conditions outside Florida deteriorating? (Y/N/DK). If 2e is YES or DO NOT KNOW, go to line 24. If 2e is NO go to line 19.	
19	2f. Are the conditions within Florida deteriorating? (Y/N/DK). If 2f is YES or DO NOT KNOW, go to line 23. If 2f is NO, go to line 20.	
20	2g. Can the breeding population rescue the Florida population should it decline? (Y/N/DK). If 2g is YES, go to line 21. If 2g is NO or DO NOT KNOW, go to line 22.	
21	If 2g is YES - Downgrade from initial finding (less imperiled)	
22	If 2g is NO or DO NOT KNOW - No change from initial finding	
23	If 2f is YES or DO NOT KNOW - No change from initial finding	
24	If 2e is YES or DO NOT KNOW - No change from initial finding	
25		
26	Final finding	Threatened

Biological Status Review Information
Regional Assessment

Additional information – Generation length is defined as the average age of parents of the current cohort, which is greater than the age at first breeding and less than the age of the oldest breeding individual. No demographic data are available for the pine snake. Florida pine snakes may reach sexual maturity in 3 years (Franz 1992), and a northern pine snake lived up to 23 years in the wild (*see* Golden et al. 2009). A Florida pine snake marked as an adult was recaptured 4–5 years later (D. Franz, pers. commun. 2010). We infer a mean generation length of 8 years.

Sub-criterion A2. – We assume that the Florida pine snake population has declined as the human population in Florida has increased and converted suitable habitat to urban, agricultural, and other land uses. According to the U.S. Census Bureau, Florida's human population increased by 23.5% from 1990 through 2000 and by 16.0% from 2000 through 2009. From 1985–89 to 2003 (a period of 14–18 years), 15.5% of Florida's sandhill habitat, 12.4% of scrub, and 9.2% of pinelands were converted to other uses, primarily urban or other developed uses (Kautz et al. 2007). Other habitats used by Florida pine snakes experienced the following conversion to other land uses: shrub and brushland 36.3%, upland forest 11.3%, dry prairie 25.4%, and coastal strand 10.8% (Kautz et al. 2007). Actual estimates of Florida pine snake populations do not exist, but we suspect that loss and degradation of habitat would not have resulted in a >30% population decline within the past 24 years, particularly considering Florida's programs for purchasing public conservation lands (e.g., Preservation 2000 and Florida Forever). Prescribed fire is used by most public land managers to manage many of the habitats used by Florida pine snakes. Unlike some sandhill species, the Florida pine snake apparently tolerates fire-suppressed sandhill habitat and will use xeric hammock and mixed pine-hardwood forests (Franz 2005, Miller 2008), although the presence of more open habitats in the vicinity are probably necessary. Collection for pets is probably not a significant threat because of its fossorial habits.

Sub-criterion A3. – Three generations from 2010 would be 2034. Florida's population is projected to increase by 31.8% by 2035 (Zwick and Carr 2006). The exact relationship between human population increase and habitat loss is unknown. Much of the population increase could occur in urban areas, and residential development in suburban and rural areas may not eliminate snake populations. Although pine snakes use human-altered habitats (Franz 2005, Miller 2008), populations decline in habitats that have been fragmented by roads or residential developments. This is a large-bodied species with a relatively large home range that suffers mortality from vehicles, landowners, and pets. Of the potential habitat identified using GIS analysis, 76% is on private land (B. Stys, FWC, pers. commun. 2010). Both public and private lands will continue to experience habitat degradation from altered fire regimes (timing, intensity, fire-return interval, and season) (D. Printiss, The Nature Conservancy, pers. commun. 2010), leading to future population declines. There are ca. 900,000 ha (2.2 million acres) of fire-dominated natural communities on all publicly managed state lands, and ca. 336,000 ha (830,000 acres) were reported to have been prescribe burned in fiscal year 2009–10 within the fire interval necessary to maintain optimal habitat conditions (State of Florida Land Management Uniform Accounting Council 2010). This means that 61% of fire-dominated communities are being fire suppressed. This trend of backlogged, fire-suppressed communities has occurred each year all the way back to the mid-1970's when state agencies in Florida first began using fire as a management tool, and these backlogged acres, on average, are not decreasing (R. Owen, Florida Department of

Environmental Protection, pers. commun. 2010). Because of this downward trend, the available optimal habitat for upland species is projected to continue to decrease on the very lands that were meant to conserve them. The ability of Florida pine snake populations to continue to persist on fire-suppressed public and private lands is unknown. Suspected declines in pocket gopher populations (Miller et al. 2008) will probably continue, affecting those pine snakes that rely on pocket gophers for underground retreats and food. In a GIS analysis conducted by Cox and Kautz (2000), 12 public conservation lands have enough habitat to support over 200 adult snakes, assuming a population density of 1 snake/20 ha. The BRG was split regarding whether a 30% population decline will occur in 3 generations; 2 of 5 members suspected the decline would be <30% because populations can persist in ruderal habitats and efforts are being made to restore degraded sandhill habitat. For example, a 3-year multi-state sandhill ecological restoration project will enhance restoration on public and private lands by providing additional resources to meet sandhill restoration goals, significantly increasing the quality and quantity of habitat for wildlife species on 6,740 ha (16,655) acres of sandhill habitat in Florida by 2012 (http://myfwc.com/wildlifelegacy/fundedprojects/GrantDetails.aspx?ID=215). Another project will completely or partially restore 539 ha (1,333 acres) of sandhill and scrub habitats to benefit wildlife on Apalachee Wildlife Management Area (WMA), Big Bend WMA, Guana River WMA, and Lake Wales Ridge Wildlife and Environmental Area by 2012 (http://myfwc.com/wildlifelegacy/fundedprojects/GrantDetails.aspx?ID=229). Florida pine snake populations will also benefit from management of public lands for red-cockaded woodpeckers (Picoides borealis) and gopher tortoises (FWC 2007).

Sub-criterion B1. – Historically, the extent of occurrence of the Florida pine snake was the entire state, exclusive of the Everglades and Florida Keys (110,210 km^2; 42,552 mi^2). There are museum, FNAI, and literature records from 38 counties since 1990. The total land area of these 38 counties is ca. 76,800 km^2 (29,650 mi^2), which is a conservative estimate of the current extent of occurrence.

Sub-criterion B2. – A GIS analysis of potential habitat for the species identified 19,983 km^2 (7,716 mi^2) of potential habitat (B. Stys, FWC, pers. commun. 2010), which we assume is equivalent to the area of occupancy. The FWC 2003 land-cover classes that comprised the potential habitat were pinelands (8,939.8 km^2; 3,451.7 mi^2), improved pasture (3,364.8 km^2; 1,299.2 mi^2), sandhill (3,080.4 km^2; 1,189.4 mi^2), shrub and brushland (2,658.1 km^2; 1,026.3 mi^2), sand pine scrub (785.4 km^2; 303.2 mi^2), xeric oak scrub (592.6 km^2; 228.8 mi^2), dry prairie (356.4 km^2; 137.6 mi^2), unimproved pasture (148.0 km^2; 75.1 mi^2), and coastal strand (122.1 km^2; 47.1 mi^2). Only pinelands, shrub and brushland, dry prairies, and pastures with dry soils were included as potential habitat. A continuing population decline is suspected because of continuing habitat loss and degradation, but there is no evidence of extreme fluctuations, and we do not consider the range of the species to be severely fragmented because of its tolerance of many disturbed habitats.

Criterion C. – No data on population densities exist for the Florida pine snake, but 2 telemetry studies have provided information on home range sizes. In Putnam County, Florida, 3 males had home ranges of 32.5–138.7 ha (mean 73.3 ha), whereas 3 females had home ranges of 10.6–16.9 ha (mean 13.5 ha) (Franz 2005). Home ranges of the 3 males did not overlap, whereas the home ranges of all 3 females overlapped each other and at least 1 male. In southwestern Georgia, 8

males had home ranges of 25.7–156.8 ha (mean 70.1 ha), and 4 females had home ranges of 18.6–80.7 ha (mean 37.5 ha) (Miller 2008). The mean home range size of both sexes combined was 57 ha in Florida and 59.2 ha in Georgia. These studies were conducted on protected lands with presumably good habitat and pine snake populations. Obviously, populations may not be as dense on all conservation lands or private lands. If we assume that all potential habitat (1,998,413 ha) is occupied by snakes, home ranges do not overlap, and home range size is 157 ha (the largest home range size found during the 2 studies), then the total population in Florida would be 12,729 adult snakes. This is equivalent to 0.006 snakes/ha. If we use the mean home range size of 58 ha, then the total population would be 34,455 adult snakes (density of 0.17 snakes/ha).

APPENDIX 1: Brief biographies of the Florida pine snake Biological Review Group members

Kevin M. Enge received his M.S. in Wildlife Ecology and Conservation from the University of Florida and B.S. degrees in Wildlife and Biology from the University of Wisconsin–Stevens Point. He is currently an Associate Research Scientist in the Reptile and Amphibian Subsection of the Wildlife Research Section, Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission (FWC). He has worked for FWC since 1989, serving as a nongame survey and monitoring biologist and the Herp Taxa Coordinator. He has conducted numerous surveys of both native and exotic amphibians and reptiles, and he has published >60 scientific papers and 25 reports.

Steve A. Johnson received his Ph.D. from the University of Florida and M.S. and B.S. degrees from the University of Central Florida. He is an Assistant Professor of Urban Wildlife Ecology at the University of Florida, and he holds a teaching and extension position in the Department of Wildlife Ecology and Conservation, Gulf Coast Research and Education Center. His area of expertise is natural history and conservation of amphibians and reptiles, especially those using isolated wetlands, and he has >60 publications.

Richard D. Owen received his M.S. and B.S. in Biology from the University of Central Florida. He is currently a District 2 Environmental Specialist for the Department of Environmental Protection, Florida Park Service specializing in aquatic systems and prescribed fire management at 40 north Florida state parks. He has over 22 years of vertebrate survey and monitoring experience in the southeastern United States. His area of expertise is natural history and distribution of Florida's amphibians and reptiles. He has been involved with over 30 publications on amphibians and reptiles.

Thomas E. Ostertag received his M.S. in Biological Sciences from the University of West Florida and B.S. degrees in Anthropology and Biological Sciences from Florida State University. He is currently the Listed Species Conservation Ecologist in the Species Conservation Planning Section of the Division of Habitat and Species Conservation, FWC. His areas of expertise are the ecology of ephemeral ponds and fire ecology. He has published several papers on the effects of fire in upland pine ecosystems.

David Printiss received B.S. in Biological Sciences from Florida State University. He is currently the Northwest Florida Program Director for The Nature Conservancy and is responsible for management and restoration of over 30,000 acres across 12 preserves. As a Conservancy Field Zoologist, he has surveyed nearly all conservation lands in northern Florida in order to provide rare species and natural community inventories and management plans. Although much of his current work is related to natural community restoration, his early training was in herpetology, and he co-authored many survey and management recommendation reports when he worked for the Florida Natural Areas Inventory.

APPENDIX 2. **Summary of letters and emails received during the solicitation of information from the public period of September 17, 2010 through November 1, 2010.**

No information about this species was received during the public information request period.