

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

## Scientific Name:

Pituophis ruthveni

## Common Name:

Louisiana Pine snake

## Lead region:

Region 4 (Southeast Region)

## Information current as of:

03/31/2011

## Status/Action

Funding provided for a proposed rule. Assessment not updated.

Species Assessment - determined species did not meet the definition of the endangered or threatened under the Act and, therefore, was not elevated to the Candidate status.

New Candidate

Continuing Candidate

Candidate Removal

Taxon is more abundant or widespread than previously believed or not subject

Taxon not subject to the degree of threats sufficient to warrant issuance of

Range is no longer a U.S. territory

Insufficient information exists on biological vulnerability and threats to s

Taxon mistakenly included in past notice of review

Taxon does not meet the definition of "species"

Taxon believed to be extinct

Conservation efforts have removed or reduced threats

## Petition Information

Non-Petitioned

Petitioned - Date petition received: 07/19/2000

90-Day Positive:05/04/2004

12 Month Positive:05/04/2004

Did the Petition request a reclassification? **No**

**For Petitioned Candidate species:**

Is the listing warranted(if yes, see summary threats below) **Yes**

To Date, has publication of the proposal to list been precluded by other higher priority listing?  
**Yes**

Explanation of why precluded:

Higher priority listing actions, including court-approved settlements, court-ordered and statutory deadlines for petition findings and listing determinations, emergency listing determinations, and responses to litigation, continue to preclude the proposed and final listing rules for this species. We continue to monitor populations and will change its status or implement an emergency listing if necessary. The Progress on Revising the Lists section of the current CNOR (<http://endangered.fws.gov/>) provides information on listing actions taken during the last 12 months.

**Historical States/Territories/Countries of Occurrence:**

- **States/US Territories:** Louisiana, Texas
- **US Counties:**County information not available
- **Countries:** United States

**Current States/Counties/Territories/Countries of Occurrence:**

- **States/US Territories:** Louisiana, Texas
- **US Counties:** Bienville, LA, Natchitoches, LA, Sabine, LA, Vernon, LA, Angelina, TX, Jasper, TX, Newton, TX, Sabine, TX
- **Countries:**Country information not available

**Land Ownership:**

Current potentially occupied habitat in Louisiana and Texas is estimated to be approximately 65,910.4 hectares (ha) or 162,867.5 acres (ac); 53.4 percent (35,206.5 ha or 86996.8 ac) occurring on public lands (Kisatchie, Angelina, and Sabine National Forests and U.S. Department of Defense (DOD) lands at Fort Polk, Louisiana) and 46.6 percent (30,704.8 ha or 75,872.9 ac) in private ownership.

**Lead Region Contact:**

ARD - Ecological Services, Lorna Patrick, 850-769-0552, [lorna\\_patrick@fws.gov](mailto:lorna_patrick@fws.gov)

**Lead Field Office Contact:**

Lafayette ESFO, Michael Sealy, 337 291-3123, [michael\\_sealy@fws.gov](mailto:michael_sealy@fws.gov)

**Biological Information**

## Species Description:

Pine snakes (genus *Pituophis*) are large, short-tailed, powerful constricting snakes with keeled scales, a single anal plate (the scale covering the cloaca) and disproportionately small heads (Conant and Collins 1991, pp. 201-202). Their snouts are pointed and they are good burrowers. The Louisiana pine snake (*P. ruthveni*) has a buff to yellowish ground color with dark brown to russet dorsal blotches covering its total length (Conant and Collins 1991, p. 203; Vandeventer and Young 1989, p. 35). The belly of the Louisiana pine snake may be unmarked or boldly patterned with black markings. The Louisiana pine snake resembles a rather heavy-bodied bullsnake (*P. melanoleucus sayi*), but differs from this species by having less dorsal blotches (40 or less). The Louisiana pine snake is variable in both coloration and pattern, but a characteristic feature is that its body markings are always conspicuously different at opposite ends of its body. Blotches run together near the head, often obscuring the ground color, and then become more separate and well-defined towards the tail. Typically, there are no noticeable head markings, although rarely a light bar or stripe may occur behind the eye. The length of adult Louisiana pine snakes ranges from 122 to 142 centimeters (cm) (48 to 56 inches (in)) (Conant and Collins 1991, p. 203).

## Taxonomy:

Stull (1929, pp. 2-3) formally described the Louisiana pine snake as a pine snake subspecies (*P. m. ruthveni*) based on two specimens taken in Rapides Parish, Louisiana. Reichling (1995, p. 192) reassessed this snake's taxonomic status and concluded that the Louisiana pine snake was geographically isolated and phenetically distinct, and thus a valid evolutionary species. The Louisiana pine snake has subsequently been accepted as a full species, *P. ruthveni* (Collins and Taggart 2002, p. 33; Crother 2000, p. 69; Rodriguez-Robles and Jesus-Escobar 2000, p. 46). We have carefully reviewed the taxonomic research for the Louisiana pine snake and conclude that this species is a valid taxon.

## Habitat/Life History:

Louisiana pine snakes are endemic to the westerly extent of the longleaf pine ecosystem that historically existed in Louisiana and Texas. Louisiana pine snake habitat consists of sandy, well-drained soils in open pine forest (especially longleaf-pine savanna), a sparse midstory, and well-developed herbaceous ground cover dominated by grasses and forbs (Rudolph and Burgdorf 1997, p. 117). These conditions are created and maintained by recurrent low-intensity ground fires that occur on a 3 to 5 year return interval. In the absence of recurrent fire, suitable Louisiana pine snake habitat conditions are lost due to vegetative succession. Louisiana pine snakes have also been found in grasslands and pine plantations that contain sufficient herbaceous ground cover, and sandy soils (Reichling et al. 2008, p. 9). Telemetry data indicate that Louisiana pine snakes are most often found within or near Baird's pocket gopher (*Geomys breviceps*) burrow systems (Ealy et al. 2004, p. 389; Himes et al. 2006, p. 107), and that they use these burrow systems as nocturnal refugia, as hibernacula, and to escape from fire (Rudolph and Burgdorf 1997, p. 117; Rudolph et al. 1998, p. 147; Ealy et al. 2004, p. 386). Pocket gophers are the primary prey of the Louisiana pine snake (Himes 2000, p. 97; Rudolph et al. 2002, p. 58), although the species has also been known to eat eastern moles (*Scalopus aquaticus*), mice (*Peromyscus* sp.), cotton rats (*Sigmodon hispidus*), and turtle (probably *Trachemys scripta*) eggs (Rudolph et al. 2002, p. 59). Louisiana pine snakes were observed by Ealy et al. (2004, p. 391) to be semi-fossorial and essentially diurnal. Ealy et al. (2004, p. 390) documented that the species spent 59 percent of daylight hours (sunrise to sunset) below ground and moved an average of 163 meters (m) (541 feet (ft)) per day. Furthermore, Louisiana pine snakes were relatively immobile [i.e., moved less than 10 m (33 ft) on 54.5 percent of days monitored and all recorded movements occurred during daytime (Ealy et al. 2004, p. 391). Louisiana pine snakes used Baird's pocket gopher burrows (80.9 percent), decayed or burned stumps (15.4 percent), or nine-banded armadillo (*Dasypus novemcinctus*) burrows (3.7 percent) as underground refugia (Ealy et al. 2004, p. 389). Himes et al. (2006, p. 107) found that Louisiana pine snakes moved 118 m (387 ft) (range 2 to 1159 m (6.6 to 3,802 ft)) between consecutive days, and that the average home range size was 33.2 ha (82 ac) (range 6.5 to 108 ha (16 to 267 ac)). Due to its semi-fossorial habits, rarity, and secretive

nature, Louisiana pine snakes are difficult to locate and capture, even in areas where they are known to occur (Ealy et al. 2004, p. 384). No nests of this species have been located in the wild.

Sexual maturity may be attained at an approximate length of 120 cm (4 ft) and an age of approximately three years (Himes et al. 2002, p. 686). Captive Louisiana pine snakes may live over 30 years, but females have not reproduced beyond the age of 18 years (Reichling 2008, p. 4, Appendix A). Captive Louisiana pine snakes have a low reproductive rate, with a mean clutch size of 4 eggs (Reichling 1990, p. 221).

### **Historical Range/Distribution:**

The Louisiana pine snake historically occurred in portions of west-central Louisiana and extreme east-central Texas. This area coincides with a disjunct portion and the most westerly occurrence of the longleaf pine ecosystem situated west of the Mississippi River. The U.S. Forest Service (USFS) Wildlife Habitat and Silviculture Laboratory in Nacogdoches, Texas, has compiled a 'historical records' database of all known Louisiana pine snake locations (excluding telemetry data) from 1927 to 2010 (n = 216 occurrence records of 205 individuals at 158 unique locations). Based on this database, there are historical records for the Louisiana pine snake from seven parishes in Louisiana (Beauregard, Bienville, Jackson, Natchitoches, Rapides, Sabine, and Vernon) and 12 counties in Texas (Angelina, Hardin, Houston, Jasper, Nacogdoches, Newton, Polk, Sabine, San Augustine, Trinity, Tyler, and Wood). Single Louisiana pine snake records exist for Calcasieu and Jefferson Davis Parishes in Louisiana (Williams and Cordes 1996, p. 35), but these records are considered suspect by the Natural Heritage Division of the Louisiana Department of Wildlife and Fisheries (Shively 1999, pers. comm.) and have not been included in the historical records database. Similarly, a previously reported Louisiana pine snake record from Cherokee County, Texas, was erroneous (Pierce 2009, pers. comm.), and two historical Louisiana pine snake records from Montgomery and Walker Counties in Texas were excluded from the database because these specimens have been re-classified as *Pituophis catenifer* (Pierce 2008, pers. comm.). Two records from Wood County, Texas (1956 and 1973) were outside of the longleaf pine habitat in what was recently observed to be oak savanna (Rudolph 2011, pers. comm.). The USFS, Southern Research Station conducted limited trapping (10,980 trap days over 4 years) in the vicinity of the historic collection sites with negative results (Rudolph 2011, pers. comm.). It should be noted that most of the sandy longleaf pine-dominated savannas preferred by the Louisiana pine snake had been lost by the mid-1930's (Bridges and Orzell 1989, p. 246; Frost 1993, p. 30). Therefore, it is extremely likely that other undocumented populations of this species historically occurred but were lost before the 1930s, since virtually all virgin timber in the south was cut during intensive logging from 1870 to 1920 (Frost 1993, p. 38).

### **Current Range Distribution:**

Louisiana pine snake trapping has been conducted by the USFS, the DOD (Fort Polk), the Memphis Zoo, and the Louisiana Department of Wildlife and Fisheries (LDWF). In total, trapping from throughout the historic range (excluding 10 captures in 2008 and 2009) of the Louisiana pine snake has resulted in 63 captures during 251,059 trap days. Based on counties or parishes with multiple recent (1990 to 2010) observations, extant Louisiana pine snake populations occur in four parishes (Bienville, Natchitoches, Sabine, and Vernon) in Louisiana and four counties (Angelina, Jasper, Newton, and Sabine) in Texas. However, the distribution of Louisiana pine snakes within these parishes and counties is restricted because intensive land use activities and the disruption of natural fire regimes has decreased the quantity and quality of the intervening areas as habitat for this species (Rudolph et al. 2006, p. 470). Existing Louisiana pine snake populations occur in seven general areas, all of which are primarily concentrated on public lands (DOD lands at Fort Polk and Peason Ridge, Louisiana and the Kisatchie, Angelina, and Sabine National Forests) and privately-owned industrial timberlands in Louisiana and Texas. A single observation of a Louisiana pine snake crossing a road in 1994 may indicate that an additional remnant Louisiana pine snake population exists in Tyler County,

Texas. Furthermore, a single observation of a Louisiana pine snake found dead along a road in 2001 may indicate that the current Louisiana pine snake population in Natchitoches Parish may travel into extreme northwestern Rapides Parish, Louisiana.

In their status assessment, Rudolph et al. (2006, p. 469) concluded that the failure to document existing Louisiana pine snake populations at known historical localities, coupled with the extensive documented loss, degradation, and fragmentation of longleaf pine habitat, indicates that the Louisiana pine snake has been extirpated from significant portions of its historical range. This assertion is supported by range-wide trapping results and the historical records database. Based on the absence of Louisiana pine snake captures during 118,052 trap days, and the lack of sightings between 1990 to 2010, the Louisiana pine snake has likely been extirpated from three parishes (Beauregard, Jackson, and Rapides) in Louisiana and seven counties (Hardin, Houston, Nacogdoches, Polk, San Augustine, Trinity, and Wood) in Texas.

Rudolph et al. (2006, p. 467) assessed habitat conditions during 1999 and 2000 at the locations of all historical Louisiana pine snake records ( $n = 118$  localities) known at that time. Rudolph et al. (2006, p. 467) found that 70 percent (26 of 37) of the localities on public lands were in excellent or good condition, whereas only 33 percent (27 of 81) of the localities on private lands were in excellent or good condition. Due to habitat fragmentation, most sites with excellent or good habitat were isolated and small (typically a few hundred hectares, or less (Rudolph et al. 2006, p. 466)). Based on the low capture rates and limited habitat availability, Rudolph et al. (2006, p. 468) concluded that remnant Louisiana pine snake populations are not large.

Currently, trapping (which is expensive, labor intensive, and has a low success rate) is the only available method for surveying Louisiana pine snake populations. Although the general habitat requirements for the Louisiana pine snake are known, currently available habitat models, which delineate the distribution of potential habitat within the currently estimated, occupied range of extant populations, are based primarily on preferable soil types. Due to the time required and expense of trapping and the only recently available (Wagner et al. 2009a) predictive habitat model, sufficient Louisiana pine snake surveys have not occurred in all areas of potential habitat. Thus, trapping efforts to date have not been sufficient to precisely delineate the boundaries of the occupied range of extant populations. Consequently, although trapping data and opportunistic sighting records were used to establish the boundaries of occupied ranges (see below); the estimates derived from these data are approximations.

A population is defined here as a group of Louisiana pine snakes with the potential for genetic exchange, that is isolated from other such groups. In their status assessment paper, Rudolph et al. (2006, p. 467) used a combination of individual records and the presence of contiguous habitat to determine that six Louisiana pine snake populations were in existence. However, since the time of that assessment, an additional Louisiana pine snake population has been located on the Kisatchie District of the Kisatchie National Forest in Louisiana. To estimate the acreage of habitat occupied by each of these seven populations (occupied habitat), recent Louisiana pine snake records ( $n = 110$ , from 1990 to 2007) containing location data were plotted in a Geographic Information System (GIS). Using ArcMap (Version 9.2), a minimum convex polygon (MCP) was drawn around the clusters of records within each population, and a one kilometer (km) (0.6 mile (mi)) buffer was drawn around each MCP. The MCP was buffered to accommodate the fact that trap locations were not placed on the landscape with the intent of delineating population boundaries. Because trapping results are a function of trap location selection, trap success, and true presence or absence, trapping data only approximate Louisiana pine snake use of an area. A one km (0.6 mi) buffer was used because telemetry data indicate this is a reasonable approximation of the area that a Louisiana pine snake may use during one or more years (Rudolph 2008a, pers. comm.). For each extant Louisiana pine snake population, the buffered MCP was used to estimate the acreage of occupied habitat and to determine land ownership (USFWS). This methodology may underestimate or overestimate the actual amount of occupied habitat for each population. Using this method, the acreage of occupied habitat may be underestimated if undocumented Louisiana pine snakes occur outside of the current estimated population boundaries. Conversely, even though unsuitable features (i.e., water and cities) were excluded from these estimates, the acreage of occupied habitat may be

overestimated because the actual amount of suitable habitat (based on soils and vegetation) within each polygon is currently unknown.

Using this methodology, it can be estimated that the seven extant Louisiana pine snake populations occur on 26,482 ha (65,438 ac) of DOD lands, 8,640 ha (21,350 ac) of USFS lands, 84 ha (206 ac) of State Lands, and 30,705 ha (75,873 ac) of private lands. In Louisiana, the following populations and acreages have been identified: (1) the Bienville, LA population (located on privately owned industrial timberland in Bienville Parish and a section of the Winn District of the Kisatchie National Forest in extreme northern Natchitoches Parish) occupying 27,966 ha (69,105 ac) of private land, 588 ha (1,452 ac) of USFS lands, and 84 ha (206 ac) of State Lands; (2) the Kisatchie, LA population (located on the Kisatchie District of the Kisatchie National Forest in Natchitoches Parish) occupying 1,514 ha (3,741 ac) of USFS land; (3) the Peason Ridge, LA population (located on Peason Ridge Military Reservation in Vernon and Sabine Parishes) occupying 1,923 ha (4,751 ac) of DOD lands and 12 ha (29 ac) of private lands; and (4) the Fort Polk, LA population (located on Fort Polk Military Reservation and the Calcasieu-Vernon District of the Kisatchie National Forest in Vernon Parish) occupying 24,559 ha (60,687 ac) of DOD lands, 2,382 ha (5,885 ac) of USFS lands, and 36 ha (88 ac) of private lands. In Texas, the following populations and acreages have been identified: (5) the Sabine, TX population (located on the southern section of the Sabine National Forest in Sabine County) occupying 320 ha (791 ac) of USFS lands and 71 ha (176 ac) of private lands; (6) the Scrappin' Valley, TX population (located on privately owned industrial timberland in Newton County) occupying 2,047 ha (5,057 ac) of private land; and (7) the Angelina, TX population (located on the southern section of the Angelina National Forest in Angelina and Jasper Counties) occupying 3,837 ha (9,482 ac) of USFS lands and 574 ha (1,418 ac) of private lands.

Improvement of habitat modeling and additional field surveys in potential habitat areas identified by this methodology are needed to improve estimates of the amount and location of currently occupied and preferred Louisiana pine snake habitat.

### **Population Estimates/Status:**

The Louisiana pine snake is recognized as one of the rarest snakes in North America (Young and Vandeventer 1988; Himes et al. 2006, p. 114). The Louisiana pine snake was classified in 2007 as endangered on the IUCN (World Conservation Union) Red List of Threatened Species (version 3.1; <http://www.iucnredlist.org/>). Because basic life history information is lacking for this species, no estimates exist regarding the acreage or population size necessary to support a viable Louisiana pine snake population. Additionally, the current and future status of the Louisiana pine snake must be viewed in light of the fact that most remnant Louisiana pine snake populations will probably remain demographically and genetically isolated into the future.

Due to its semi-fossorial habits, rarity, and secretive nature, Louisiana pine snakes are difficult to locate and trap, even in areas where they are known to occur (Ealy et al. 2004, p. 384). To date, most Louisiana pine snake records have been from trapping and opportunistic sightings. Trapping effort data are used to estimate trap success (i.e., the number of trap days required to catch one snake) for each extant population. Trapping has provided important information on Louisiana pine snake occurrences. However, population densities cannot be reliably estimated from trapping data because mark-recapture analyses cannot be conducted due to insufficient numbers of Louisiana pine snake recaptures. Consequently, no estimates of Louisiana pine snake population densities exist. The best available indices of Louisiana pine snake population abundance are trap success and the number of occurrence records per population. Although we report these indices for each extant population, it is unknown how these metrics relate to true population size.

(1) The Bienville, LA population. The estimated occupied habitat for this population occurs primarily on privately owned industrial timberland in Bienville Parish and a section of the Winn District of the Kisatchie National Forest in extreme northern Natchitoches Parish. Trap success for this population (including data from the Winn District, LA) is estimated to be 1:1,096 (27 captures (excluding recaptures) out of 29,598 trap

days) from 1997 to 2010. Furthermore, trapping efforts for this population during the last three years (2008 to 2010) have resulted in nine captures (plus two recaptures) with a 1:978 success rate (8,799 trap days). Although, trapping from a previous effort on the Winn District between 2000 to 2001 provided 2 captures (in addition to one recapture), trap efforts on the Winn District from 2004 to 2010 have produced zero captures in 4,950 trap days. While trapping success may vary annually, the trapping success in this area has been significantly better than for any other populations. Based on trap success and occurrence records (36 records from 1997 to 2010), the Bienville population is widely believed to be the largest extant Louisiana pine snake population (Rudolph et al. 2006, p. 465; Reichling et al. 2008, p. 10). Within occupied habitat, most records for this population have occurred on 12,353 ha (30,525 ac) of privately-owned industrial timberlands in Bienville Parish, Louisiana (Reichling et al. 2008, p. 1). On this timberland, two disjunct Louisiana pine snake Core Management Areas (CMAs) (the 344 ha (851 ac) Kepler Lake site and the 348 ha (859 ac) Sandy Lands site) have been voluntarily established by the landowners. These sites are managed for the Louisiana pine snake with thinning, longleaf pine restoration, limited herbicide use, and prescribed burning. The Kepler Lake CMA had demonstrated the greatest trap success (1:326) and number of occurrence records (n = 26, as of 2008) of any site sampled within the range of the species. Consequently, Reichling et al. (2008, p. 10) believed this site was critical for the preservation of this species. Based on information from the current landowner (Cook 2011, pers. comm.), 177 ha (438 ac) of the Kepler Lake CMA and 210 ha (518 ac) of the Sandy Lands CMA have been converted to longleaf pine since 2001. Additionally, during early 2011, the present landowner completed prescribed burning of 227 ha (560 ac) at the Kepler Lake CMA and 259 ha (639 ac) at the Sandy Lands CMA (Cook 2011, pers. comm.). Beneficial understory (hardwood and shrub) control by application of herbicide in banded rows instead of broadcast spray occurred on 426 ha (1,053 ac) of sandy soils during 2009 to 2011 (Cook 2011, pers. comm.). However, many of the timberlands surrounding those CMAs are managed with intensive silvicultural practices. There are no estimates of the amount of habitat necessary to support a viable Louisiana pine snake population. Nonetheless, Reichling et al. (2008, p. 10) did not believe that isolated management areas that were 324 to 405 ha (800 to 1,000 ac) or less in size were sufficient to support viable Louisiana pine snake populations, and therefore the snakes in the Kepler Lake CMA were likely dependent upon the surrounding habitat. Consequently, Reichling et al. (2008, p. 10) felt that it was essential to Louisiana pine snake conservation to restore and preserve the thousands of hectares (acres) of privately-owned upland xeric habitat that surround the Kepler Lake CMA. Increasingly intensive land use within occupied habitat outside of the two CMAs has likely degraded the quality of this habitat for the Louisiana pine snake. Furthermore, the entire 12,353 ha (30,525 ac) parcel of Louisiana pine snake habitat on this property in Bienville Parish was purchased by a Timber Investment Management Organization (TIMO) in 2006. In 2008, this entire property was sold to another TIMO. In addition, this population is likely experiencing habitat loss and degradation as a result of conversion to pine plantation management throughout this population's range. Consequently, the status of this Louisiana pine snake population is uncertain.

(2) The Kisatchie, LA population. The estimated occupied habitat (1,517 ha (3,748 ac)) for this population occurs exclusively on the Kisatchie Ranger District of the Kisatchie National Forest, Louisiana. No Louisiana pine snakes were captured during 12,011 trap days (1997 to 2003) on the Kisatchie District of the Kisatchie National Forest. However, two recent (2003 and 2007) Louisiana pine snake records (one non-capture sighting and one hand-capture) exist for this population. Past trapping did not occur in the locations of these new Louisiana pine snake records. Furthermore, despite the presence of substantial amounts of suitable habitat on the Kisatchie District, past trapping did not sample the best habitat (Rudolph et al. 2006, p. 469). Active habitat management for the federally endangered red-cockaded woodpecker (*Picoides borealis*; RCW) and the Louisiana pine snake occur within the estimated occupied habitat of this population. All the 1,517 ha (3,748 ac) Louisiana pine snake occupied habitat was prescribed burned during 2008 to 2010 (USDA Forest Service 2010, pers. comm.). The Kisatchie District has 8,452 ha (20,886 ac) of potential Louisiana pine snake habitat (based strictly on soils data) of which 2,456 ha (6,068 acres) and 2,155 ha (5,324 ac) were prescribed burned in 2009 and 2010, respectively. Additionally, commercial timber harvest (thinning) occurred on 225 ha (557 ac) of potential habitat from 2007 to 2009. Utilization of the Landscape-scaled Resource Selection Functions Model of Potential Louisiana Pine Snake Habitat (LRSF Model) (Wagner et al. 2009a, p. 15) indicated that 795 ha (1,965 ac) of potentially preferable habitat exists within the Occupied Habitat MCP area

(1,517 ha (3,748 ac)). More recently, the LRSF Model indicated that 11,904 ha (29,416 ac) of potentially preferable habitat exists within the area of active habitat management for the RCW (RCW Habitat Management Area (HMA)); versus past analyses using soils data that identified 8,452 ha (20,886 ac) of potential habitat within the RCW HMA. Of that 11,904 ha (29,416 ac) of LRSF Model habitat, 90 percent was prescribed burned during 2008 to 2010. Thinning occurred on 347 ha (857 ac) of LRSF Model habitat on the RCW HMA and 28 ha (70 ac) of LRSF Model habitat within occupied habitat in 2008 to 2010 (USDA Forest Service 2010, pers. comm.). This population is not threatened by ongoing habitat loss. The existence of two Louisiana pine snake sightings since 2003 is encouraging, but estimates of trap success are not currently useful because insufficient trapping efforts have occurred in potential suitable habitat. In addition, it is unknown whether past habitat loss and degradation has reduced the current size of this population to the point where it is vulnerable to decreased demographic viability or stochastic environmental factors (e.g., weather events, disease). Consequently, the status of this population is uncertain. Due to the lack of recent trapping effort (none since 2003), assessment of this population remains difficult. Resumption of trapping efforts in potentially preferable habitat (as indicated by the LRSF Model and pocket gopher presence) would strengthen the assessment of this population.

(3) The Peason Ridge, LA population. The occupied habitat (1,463 ha (3,614 ac)) for this population occurs almost exclusively on the Fort Polk, Peason Ridge Training Area (DOD lands). Trap success for this population during 2006 to 2010 has been estimated to be 1:6,863 (2 captures out of 13,725 trap days). The trapping effort for the last three years from 2008 to 2010 produced one capture in 2010. Five individual records (1997 to 2010) exist for this population; three of which were non-trap sightings. Forty percent (581 ha (1,435 ac) out of 1,463 ha (3,614 ac) of occupied habitat was prescribed burned during 2008 to 2010 (U.S. Department of the Army 2010, pers. comm.). However, a large portion of potentially occupied habitat occurs within an artillery impact range which is known to experience wildfires but the extent is unknown. Furthermore, the DOD prescribed burned 62.5 percent (6,985 ha (17,260 ac) out of 11,169 ha (27,600 ac)) of potential Louisiana pine snake habitat during 2008 to 2010. Additionally, 1,104 ha (2,727 ac) of potential habitat was thinned during 2008 to 2010. Utilization of the LRSF Model indicated that 672 ha (1,661 ac) of potentially preferable habitat exists within the Occupied Habitat MCP area (1,463 ha (3,614 ac)). More recently, the LRSF Model indicated that only 3,446 ha (8,515 ac) of potentially preferable habitat exists at the Peason Ridge Training Area compared to the potential habitat estimate used for past analyses (11,169 ha (27,600 ac)) (U.S. Department of the Army 2010, pers. comm.). Active habitat management for the RCW and the Louisiana pine snake occurring at this site has likely stabilized or increased the amount of potential habitat that exhibits suitable vegetative characteristics. However, trap success and occurrence records continue to remain low, and it is unknown whether past habitat loss and degradation has reduced the current size of this population to the point where it is vulnerable to decreased demographic viability or stochastic environmental factors. Additionally, the LRSF Model suggests that significantly less potentially preferable habitat may exist at Peason Ridge than was previously determined. Consequently, the status of this population is uncertain. Currently, increased trapping effort in potentially preferable habitat (as indicated by the LRSF Model and pocket gopher presence) is being implemented to strengthen the assessment of this population.

(4) The Fort Polk, LA population. The majority of occupied habitat (24,559 ha (60,687 ac)) for this population occurs on the Fort Polk, Louisiana, Main Post (DOD lands) and on the Vernon Unit of the Kisatchie National Forest, Louisiana. Trap success for this population from 2000 to 2010 has been estimated to be 1:4,611 (20 captures out of 92,218 trap days). Trap success for this population over the last three years (2008 to 2010) is estimated to be 1:2,856 (4 captures out of 11,424 trap days). All captures during this period occurred on Main Post and no captures occurred on the Vernon Unit of the Kisatchie National Forest. Twenty-four records from 1997 to 2010 including five non-trap sightings exist for this population, all on DOD land. Fort Polk Main Post prescribed burned 54.5 percent (5,875 ha (14,517 ac)) out of 10,782 ha (26,643 ac)) of occupied Louisiana pine snake habitat on DOD land during 2010. Fort Polk Main Post prescribed burned 58.4 percent (9,582 ha (23,677 ac) out of 16,410 ha (40,551 ac)) of potential Louisiana pine snake habitat during 2008 to 2010. Additionally, 398 ha (984 ac) of potential habitat was thinned in 2008 to 2010. Utilization of the LRSF Model indicated that 10,729 ha (26,511 ac) of potentially preferable

habitat exists within the occupied habitat MCP area (10,782 ha (26,643 ac)). More recently, the LRSF Model indicated that 16,306 ha (40,292 ac) of potentially preferable habitat exists at the Fort Polk Main Post compared to the potential habitat estimate used for past analyses (16,410 ha (40,551 ac)) (U.S. Department of the Army 2010, pers. comm.). One-hundred (100) percent of occupied Louisiana pine snake habitat (10,802 ha (26,693 ac)) on the Vernon Unit of the Kisatchie National Forest was prescribed-burned from 2006 to 2008. Similarly, one-hundred (100) percent of the Vernon Unit of potential Louisiana pine snake habitat (44,778 ha (110,649 ac)) was prescribed-burned during 2006 to 2009 (USDA Forest Service 2009, pers. comm.). LRSF Model habitat data comparisons to occupied habitat and management actions were not available. Extensive occupied and potential Louisiana pine snake habitat exists at this site, and active habitat management for the RCW and the Louisiana pine snake has likely stabilized or increased the amount of habitat that has suitable vegetative characteristics. Despite relatively moderate trap success, the large number of occurrence records and the large amount of potentially suitable habitat under active management suggest that this Louisiana pine snake population is stable. Currently, increased trap effort in potentially preferable habitat (as indicated by the LRSF Model and pocket gopher presence) is being implemented to strengthen the assessment of this population.

(5) The Sabine, TX population. The majority of the occupied habitat (750 ha (1,854 ac)) of this population occurs on the Sabine National Forest, Texas. Trap success for this population is estimated to be 1:3,306 (4 captures (5 total, 1 was a recapture)) out of 13,225 trap days) for the period of 1993 to 2010. Only four individual records (all from trapping data obtained during 1993 to 1995) exist for this population. No trap success (0 captures per 3,980 trap days during 2008 to 2010 or any other sighting has occurred within this population since 1995. The Sabine National Forest contains 7,689 ha (19,000 ac) of potential Louisiana pine snake habitat, of which 4,047 ha (10,000 ac) currently exhibit suitable vegetative characteristics (USDA Forest Service 2007, pers. comm.). Despite the large amount of potentially suitable habitat, the majority of occupied habitat identified for this population occurs on one Habitat Management Area (HMA) within the Sabine National Forest. Active habitat management for the RCW and the Louisiana pine snake occurs within other HMAs at this site. Twenty-one HMA compartments (including occupied compartments of Fox Hunter's Hill tract) of the Sabine National Forest have specific management conditions described within a Candidate Conservation Agreement (CCA) (CCA 2003, p. 12). The Sabine National Forest prescribed burned 51 percent (8,754 ha (21,632 ac) out of 17,086 ha (42,221 ac)) of the HMA during 2008 to 2010. Furthermore, the Sabine National Forest prescribed burned 74 percent (558 ha (1,380 ac) out of 750 ha (1,854 ac)) of occupied habitat at the Fox Hunter's Hill tract during 2008 to 2010. In 2010, 209 ha (517 ac) were thinned on occupied habitat at the Fox Hunter's Hill tract. The LRSF Model indicated that 350 ha (866 ac) of potentially preferable habitat exists within the potentially occupied habitat at the Fox Hunter's Hill tract. More recently, the LRSF Model indicated that 2,424 ha (5,990 ac) of potentially preferable habitat exists within the entire HMA of 17,086 ha (42,221 ac) (USDA Forest Service 2010, pers. comm.). This population is surrounded by lands that have become unsuitable for the Louisiana pine snake due to intensive silviculture and fire suppression (Rudolph 2008b, pers. comm.). In addition, Louisiana pine snakes in this population have been negatively affected by vehicular traffic (Rudolph 2008b, pers. comm.). No Louisiana pine snake records have been reported from this population since 1995. In addition, no Louisiana pine snakes were captured from this population during 3,980 trap days in 2008 and 2009 and a cumulative total of 13,225 trap days from 2000 to 2009. The information above suggests that this population may have become extirpated or that it is vulnerable to decreased demographic viability or stochastic environmental factors. Consequently, the status of this population is uncertain, but possibly extirpated. However, the lack of recent trap captures suggests that increased trap effort in potentially preferable habitat (as indicated by the LRSF Model and pocket gopher presence) would strengthen the assessment of this population.

(6) The Scrappin' Valley, TX population. This population (1,503 ha (3,713 ac)) occurs on privately-owned property in Newton County, TX, which is being maintained, in part, as a hunting preserve. Trap success for this population is estimated to be 1:9,602 (2 captures out of 19,204 trap days) during 1997 to 2010. Trap success for this population over the last three years (2008 to 2010) is estimated to be 1:5,521 (2 captures out of 11,042 trap days). The most recent capture at this site was in 2008. Six individual records (1997 to 2010) exist for this population. Approximately 405 ha (1,000 ac) of potential habitat have been maintained as

suitable Louisiana pine snake habitat for several decades because of active prescribed burning that has occurred on this site for game and RCW management (Rudolph 2008b, pers. comm.). Additional potential habitat (approximately 4,047 ha (10,000 ac) in size) surrounding this population has historically been fire suppressed and unsuitable for Louisiana pine snake populations. However, active management is currently improving the suitability of much of this area as habitat for the Louisiana pine snake (Rudolph 2008b, pers. comm.). The LRSF Model indicated that 814 ha (2,011 ac) of potentially preferable habitat exists within occupied habitat (1,503 ha (3,713 ac)). Within the Scrappin' Valley hunting preserve boundary, the LRSF Model indicated that 4,538 ha (11,214 ac) of potentially preferable habitat exists (USDA Forest Service 2010, pers. comm.). Despite Louisiana pine snake occurrences as recent as 2008, and proactive habitat management by the private landowner, the relatively low levels of trap success suggests that this population may be vulnerable to decreased demographic viability or stochastic environmental factors and indicate that the status of this population is uncertain. Relatively low trap success suggests that increased trap effort in potentially preferable habitat (as indicated by the LRSF Model and pocket gopher presence) would strengthen the assessment of this population.

(7) The Angelina, TX population. The estimated occupied habitat of this population occurs on the southern portion of the Angelina National Forest, Texas (3,837 ha (9,482 ac)); however, 574 ha (1,418 ac) occurs on private lands. Trap success for this population is estimated to be 1:3,488 (5 captures out of 17,438 trap days) during 1997 to 2010. Eight individual records (1997 to 2000) exist for this population (five were captured in traps). However, one previously captured and pit-tagged individual was found dead on a road in 2009. During the last three years (2008 to 2010), no trap success (0 captures out of 7,632 trap days) has occurred within this population. Active habitat management for the RCW and the Louisiana pine snake occurs within Habitat Management Areas (HMA) at this site. Eighteen HMA compartments of the Angelina National Forest have specific management conditions designated by agreement within the CCA for the Louisiana pine snake (CCA 2003, p. 12). The Angelina National Forest contains 8,903 ha (22,000 ac) of potential Louisiana pine snake habitat, of which 4,856 ha (12,000 ac) currently exhibit suitable vegetative characteristics (USDA Forest Service 2007, pers. comm.). The Angelina National Forest prescribed burned 87.6 percent (13,294 ha (32,849 ac) out of 15,179 ha (37,509 ac)) of the HMA during 2008 to 2010. No thinning of HMA habitat occurred during 2008 to 2010. Furthermore, the Angelina National Forest prescribed burned 90 percent (3,470 ha (8,574 ac) out of 3,862 ha (9,542 ac)) of occupied Louisiana pine snake habitat during 2008 to 2010. The LRSF Model indicated that 1,915 ha (4,732 ac) of potentially preferable habitat exists within occupied habitat (3,862 ha (9,542 ac)). Of the potentially preferable habitat, 93.4 percent (1,789 ha (4,420 ac)) has been prescribed burned during 2008 to 2010. Within the entire HMA of 15,179 ha (37,509 ac), the LRSF Model indicated that 7,835 ha (19,360 ac) of potentially preferable habitat exists (USDA Forest Service 2010, pers. comm.). Although trap success is only moderate, the relatively large number of occurrence records, a 2009 road-kill recapture record, and large amount of potentially occupied (3,862 ha (9,542 ac)) and preferable potentially occupied habitat under active management (1,789 ha (4,420 ac)) suggest that the status of this population is stable. However, the lack of recent trap captures suggests that increased trap effort in potentially preferable habitat (as indicated by the LRSF Model and pocket gopher presence) would strengthen the assessment of this population.

As of August 2010, the captive-breeding Louisiana pine snake population consists of 72 individuals (38 males and 34 females) at 21 Association of Zoos and Aquariums-accredited (AZA) institutions, which are divided into three groups of snakes separated by their different geographic origins – Bienville Parish, LA; Vernon Parish, LA; and eastern Texas (Reichling and Schad 2010, p. 1).

## **Threats**

### **A. The present or threatened destruction, modification, or curtailment of its habitat or range:**

The historical distribution of the Louisiana pine snake corresponds with the historical range of the longleaf pine ecosystem in Louisiana and Texas. Both the quantity and quality of the longleaf pine ecosystem have declined sharply in Louisiana and Texas since European settlement. The loss and degradation of the longleaf pine ecosystem, and hence of Louisiana pine snake habitat, was historically caused by logging, turpentine, fire suppression, alteration of fire seasonality and periodicity, conversion to off-site pine plantations, agriculture, and urbanization (Frost 1993, pp. 24-30). Between the 1930s and the 1980s, most of the longleaf pine forest in Louisiana and Texas was converted to extensive pine plantation monocultures (Bridges and Orzell 1989, p. 246). Consequently, the longleaf pine forest that exists today in Louisiana and Texas has been reduced to 15 and 8 percent, respectively of the acreage that existed in 1935 (Bridges and Orzell 1989, p. 246). Importantly, the estimated 1935 acreages were a fraction of those that existed pre-European settlement, since virtually all virgin timber in the south was cut during intensive logging from 1870 to 1920 (Frost 1993, p. 30). For example, only 2.9 percent of longleaf pine forests in Louisiana and Texas were uncut old-growth stands in 1935 (Bridges and Orzell 1989, p. 246). Therefore, estimates of habitat loss based on differences between 1935 and the late 1980s underestimate the true extent of habitat loss (and hence Louisiana pine snake population declines), because most of the habitat loss had already occurred by 1935. The large-scale destruction and degradation of the longleaf pine ecosystem has been implicated in the population declines of many species that are characteristic of this ecosystem, including the black pine snake (*Pituophis melanoleucus lodongi*) (a Federal candidate species), the endangered red-cockaded woodpecker, and the endangered Mississippi sandhill crane (*Grus canadensis pulla*) (Hunter et al. 2001, p. 442; USFWS 2007, p. 9).

All seven extant Louisiana pine snake populations have been affected by habitat loss, and all require active management (prescribed burning) to maintain suitable habitat conditions. Potential Louisiana pine snake habitat has been maintained or increased in some populations, whereas in other populations existing habitat continues to be lost and degraded, albeit at a slower rate than that which occurred historically. On private lands, open pine habitats containing dense herbaceous vegetation are being converted to densely-stocked off-site pine plantations that are managed with herbicides instead of fire. The use of fire is heavily restricted on private timberlands because of the expense of fire liability insurance, the reduced tolerance of off-site pine species to fire, and because of smoke management issues. In addition, the increasing trend towards the divestiture of industrial forest lands in the Southeast complicates establishing public-private partnerships and long-term forest management agreements.

The Bienville Parish, LA population of Louisiana pine snakes, arguably the largest extant population (Reichling et al. 2008, p. 10), primarily occurs on private industrial forest land. Much of this industrial forest has recently been converted to short-rotation loblolly pine plantations. Although the broadcast application of herbicides has been restricted in these plantations, these sites are managed with clearcutting at 25-year harvest rotations and the use of targeted herbicides instead of prescribed burning (Smith 2008, pers. comm.). Two disjunct Louisiana pine snake CMAs, are being beneficially managed (via longleaf pine restoration, prescribed burning, and understory control) for the Louisiana pine snake by the private landowners. However, if the conversion of forests outside of the CMAs to short-rotation loblolly plantations results in a decrease in the suitability of these areas as Louisiana pine snake habitat (Rudolph et al. 2006, p. 470), the Louisiana pine snakes occupying the CMAs may become fragmented into isolated populations. If isolation occurs, the long-term persistence of Louisiana pine snakes in the CMAs has been questioned by some authorities (Reichling et al. 2008, p. 10) based on the belief that it is unlikely that either CMA is large enough to support a viable Louisiana pine snake population. Louisiana pine snakes have been found within loblolly pine plantations at these sites outside of the CMAs (Reichling et al. 2008, p. 6). However, based on trapping surveys and location records, Rudolph et al. (2006, p. 470) concluded that areas managed with these intensive silvicultural practices (e.g., clearcutting, short rotations, planting of off-site pine species, and the use of herbicides instead of prescribed fire) do not support viable Louisiana pine snake populations. The recent buying and selling of the Bienville properties by TIMOs adds additional uncertainty regarding the future land use priorities on these sites. The current landowner and the Service have finalized the Modification to transfer a Private Stewardship Grant, formerly held by a previous landowner, to conduct habitat improvements on the two CMAs that would benefit the Louisiana pine snake (i.e., prescribed burning and midstory control).

Representatives from the current TIMO attended the 2009 and 2010 Louisiana pine snake stakeholders meetings and are continuing to implement habitat management on the two CMAs. Nonetheless, the recent conversion of a large portion of occupied habitat to short-rotation pine plantations highlights the potential conflicts between Louisiana pine snake conservation and economics on private lands. Despite the beneficial management in the two CMAs and the fact that trapping and occurrence records indicate this is the largest remaining Louisiana pine snake population, no formal conservation agreements exist for habitat occupied by this population. Furthermore, the Bienville properties are located near an area which is undergoing increasing natural gas exploration in association with a formation known as Haynesville shale. It is currently unknown if and at what level the Louisiana pine snake would be affected by those activities.

Pine forest management on public lands typically includes longer rotations than commercial forestry, as well as the retention of longleaf pine and the use of prescribed fire. Recent Louisiana pine snake records on public lands are mainly from areas where the use of fire has been effective in suppressing hardwood midstory development and in promoting well-developed herbaceous groundcover (Rudolph et al. 2006, p. 470). Forest fragmentation by roads and private inholdings and the concomitant smoke management and liability concerns, have hindered prescribed burning and have caused natural fires to be suppressed. The quality of Louisiana pine snake habitat has been a concern on Federal lands in Louisiana and Texas in recent decades due to midstory encroachment and high stand density (Rudolph et al. 2006, p. 470). These factors, coupled with insufficient burning, have limited the development of healthy ground layer herbaceous vegetation. Abundant ground layer herbaceous vegetation is important for Louisiana pine snakes and their primary prey, the Baird's pocket gopher. However, since the signing of the Louisiana pine snake CCA between the Service, the USFS, DOD (Fort Polk), Texas Parks and Wildlife Department (TPWD), and the LDWF in 2003, the signatories of that CCA have performed extensive beneficial habitat management (prescribed burning and thinning) within occupied and potential Louisiana pine snake habitat on Federal lands. The increases in the acreages of burning and thinning conducted by the signatories of the CCA appears to have improved habitat conditions on many Federal lands that support Louisiana pine snake populations (Rudolph 2008c, pers. comm.).

The extensive amounts of proactive habitat management conducted by signatories of the CCA is believed to have slowed or reversed the rate of Louisiana pine snake habitat degradation (caused by inadequate burning and subsequent vegetative succession) on many portions of Federal lands. However, it has been noted that, in some instances, prescribed burning and thinning was not occurring in areas that would benefit Louisiana pine snakes because management was being prioritized for the RCW (USDA Forest Service 2007, pers. comm.). Quantifying the extent to which these management activities have improved conditions for Louisiana pine snakes has remained difficult because vegetative responses to habitat management are not typically reported. In addition, not all areas of occupied Louisiana pine snake habitat have received recent beneficial management.

Based on our evaluation, we conclude that there is sufficient information to develop a proposed listing rule for this species due to the present or threatened destruction, modification, or curtailment of its habitat or range.

## **B. Overutilization for commercial, recreational, scientific, or educational purposes:**

Take of Louisiana pine snakes in Louisiana for commercial, recreational, scientific, or educational purposes is not currently considered a threat (Boundy 2008, pers. comm.). Given the restricted distribution, presumed low population sizes, and low reproductive potential of Louisiana pine snakes, it is likely that even moderate collecting pressure would negatively affect extant populations of this species. Webb et al. (2002, p. 64) concluded that, in long-lived snake species exhibiting low fecundity, the sustained removal of adults from isolated populations would eventually lead to extirpation. Because extant Louisiana pine snake populations are isolated, dispersal does not occur between populations. However, the Louisiana pine snake is protected by State law in Texas, and most areas in Louisiana where extant Louisiana pine snake populations occur restrict

public access or prohibit collection. In addition, the secretive nature, semi-fossorial habits, and rarity of the Louisiana pine snake likely make collection of this species difficult (Gregory 2008a, pers. comm.). Although current levels of Louisiana pine snake collection have not been quantified, there appears to be very little demand for this species by private collectors (Reichling 2008, pers. comm.).

### **C. Disease or predation:**

Disease and natural predation are not currently considered to be threats to this species.

### **D. The inadequacy of existing regulatory mechanisms:**

There are no existing regulatory mechanisms for the protection of the upland habitats required by the Louisiana pine snake. The Louisiana pine snake is listed as threatened by the State of Texas and is protected from unauthorized collection in that State. That regulation does not alleviate the loss of habitat which has caused the decline of the species. There is no state listing protection for the Louisiana pine snake in Louisiana (Gregory 2008b, pers. comm.). Collection or harassment of Louisiana pine snakes is prohibited on U.S. Forest Service properties in Louisiana (USDA Forest Service 2002, p. 1). The capture, removal, or killing of non-game wildlife from Fort Polk and Peason Ridge is prohibited without a special permit and only venomous snakes may be killed on Fort Polk and Peason Ridge if determined to be an immediate threat to personnel (U.S. Department of the Army 2008, p. 6). Malicious killing of snakes by humans is a significant issue in snake conservation because snakes arouse fear and resentment from the general public (Bonnet et al. 1999, p. 40). Intentional killing of black pine snakes by humans along the Gulf Coast has been documented (USFWS 2007, p. 8). The intentional killing of Louisiana pines snake by humans is likely, but the extent of the impacts of this stressor are unknown.

### **E. Other natural or manmade factors affecting its continued existence:**

The historic and ongoing fragmentation of the longleaf pine ecosystem, and hence of Louisiana pine snake habitat, has resulted in extant Louisiana pine snake populations that are isolated and small. Currently, the amount of habitat required to support viable Louisiana pine snake populations, and the necessary distribution of this habitat over the landscape, is not known. In addition, we currently do not know the minimum population size required to maintain self-sustaining populations of the Louisiana pine snake. Small, isolated populations may experience decreased demographic viability and increased susceptibility of extirpation from stochastic environmental factors (e.g., weather events, disease). Small, isolated populations may also experience increased threat of extirpation from genetic isolation and subsequent inbreeding depression and genetic drift. All seven extant Louisiana pine snake populations appear to be vulnerable to threats associated with fragmentation and isolation, and at least four of these populations (the Kisatchie, LA; Peason Ridge, LA; Scrappin' Valley, TX; and Sabine, TX populations) also appear to be vulnerable to threats associated with small population size.

The disruption of natural fire regimes has been detrimental to the health and extent of the longleaf pine forests within the Louisiana pine snake range. Insufficient fire, due to fire suppression and inadequate prescribed burning, is considered a primary factor responsible for the degradation of the remaining longleaf pine forest. The longleaf pine savannas occupied by Louisiana pine snakes have historically been maintained by fire. Habitat surveys conducted by Rudolph (2000, p. 7) indicate that changes in fire regimes may represent the greatest threat to Louisiana pine snake habitat quality in recent years. The use of prescribed burning as a management tool is being restricted by many foresters due to numerous factors, including liability issues, smoke management issues, limited funds and personnel, potential legal issues, and the planting of off-site pine species, which are more easily damaged by fire, instead of longleaf pine. Thus, prescribed burning is being replaced by herbicide use on many private forest properties. If herbicide use alters the composition and/or density of the ground cover vegetation and pocket gophers decline in response, it is likely that Louisiana pine snakes will decline in numbers as well (Rudolph and Burgdorf 1997, p. 118).

Roads and associated vehicular traffic, in particular, have been identified as important causes of snake mortality and population declines (Rudolph et al. 1999, p. 130; Himes et al. 2002, p. 686). Himes et al. (2002, p. 686) documented the death of 15 Louisiana pine snakes during their radio-telemetry study in Louisiana and Texas. Three of the 15 (20 percent) deaths could be attributed to vehicle mortality. Roads with moderate to high traffic levels reduce adjacent snake populations by 50 to 75 percent and measurable impacts extend up to 850 m (approximately one-half mile) from the roads (Rudolph et al. 1999, p. 130). Off-road vehicle use may also cause significant impacts to Louisiana pine snake population numbers. However, no significant data exists to quantify the impact of off-road vehicle use.

Erosion control blankets (ECBs) installed in pipeline, power line, and road rights-of-way can result in direct Louisiana pine snake mortality due to entanglement. Rudolph (2011, pers. comm.) demonstrated that synthetic erosion control blanket material caused immediate entanglement and snakes were unable to extract themselves after exposure. Extensive pipeline construction associated with Haynesville shale gas and oil exploration activities, and the subsequent increase in the use of ECBs, may be a particular threat to the Bienville, LA population (Rudolph 2011, pers. comm.).

The Louisiana pine snake has an extremely low reproductive rate, producing a very small clutch of 4 large eggs (Reichling 1990, p. 221). The Louisiana pine snake's low fecundity (reproductive output) and likely low population growth rate magnifies the effect of the above listed threats and increases the likelihood of local extirpations.

The extensive historic loss of habitat has reduced the Louisiana pine snake into seven isolated populations. Several of these populations may be vulnerable to threats associated with low population sizes. The historic and ongoing loss of potential habitat (via fire suppression, conversion to pine plantations, increases in the number and width of roads, and urbanization) on private lands in the matrix between these extant populations has essentially eliminated the potential for successful dispersal among remnant populations, as well as the potential for natural re-colonization of vacant or extirpated habitat patches. In addition, the prospects are low for securing and restoring habitat corridors between most extant populations. Snakes are vulnerable to increased intentional and unintentional mortality when they disperse outside of their home ranges and into developed areas (Bonnet et al. 1999, p. 47). Because extant Louisiana pine snake populations are few in number, small in size, and demographically isolated, any factor (e.g., habitat change, a loss of demographic viability, etc.) that results in a decline in Louisiana pine snake densities within a remnant population may be problematic for the long-term recovery of this species. Based on the assessment of the status of the seven extant populations, two populations appear to be large enough and occur on sufficient amounts of appropriately-managed habitat as to be considered stable (the Fort Polk, LA and Angelina, TX populations). The five other populations each have uncertain statuses: three because of apparently low population sizes (the Kisatchie, LA; Scrappin' Valley, TX; and Peason Ridge, LA populations), one because of apparently low population size coupled with low amounts of suitable habitat (the Sabine, TX population), and one because of threats resulting from activities (habitat conversion to short-rotation pine plantations) that are expected to decrease habitat quality (the Bienville, LA population).

Based on our evaluation, we conclude that there is sufficient information to develop a proposed listing rule for this species due to other natural or manmade factors affecting its continued existence.

### **Conservation Measures Planned or Implemented :**

The CCA (2003) for the Louisiana pine snake which includes the Service, USFS, DOD, TPWD, and LDWF was completed in 2003 and is currently being implemented. The CCA is designed to identify and establish management for the Louisiana pine snake on Federal lands in Louisiana and Texas, and provides a means for the partnering agencies to work cooperatively on projects that avoid and minimize impacts to the snake. It also sets up a mechanism to exchange information on successful management practices and coordinate research efforts. The Natural Resources Conservation Service, the Association of Zoos and Aquariums (AZA), and The Nature Conservancy have discussed potentially becoming additional signatories when the

CCA is revised in 2011. Several private landowners previously indicated interest in becoming signatories to the CCA or similar agreements with the Service. However, as of March 2011, no private landowners were formal signatories of the CCA. In addition, suggested amendments to the CCA, if adopted, will improve the ability of land managers to prioritize burning in areas that will benefit Louisiana pine snakes.

Federal partners to the CCA manage land representing an estimated 53 percent of occupied Louisiana pine snake habitat. These partners are addressing habitat management needs through pro-active land management including midstory removal, thinning, and prescribed burning. All Federal lands that contain extant Louisiana pine snake populations use prescribed burning and thinning to manage habitat for the federally endangered RCW. Because Louisiana pine snakes and RCWs both require open pine forests with fire-suppressed midstories, habitat management for the RCW generally benefits the Louisiana pine snake (Rudolph et al. 2006, p. 471). However, fire management for the RCW that is conducted in areas without well-drained sandy soils and pocket gophers will not directly benefit the Louisiana pine snake. In addition, fire management that occurs within Louisiana pine snake occupied habitat is more beneficial than fire management that occurs within potential habitat. Therefore, information on the acreage of prescribed burning and thinning that is not directly related to occupied habitat overestimates the benefit of this management to the Louisiana pine snake. During 2008 to 2010, cooperating Federal agencies conducted prescribed burning on 79,025 ha (195,275 ac) in occupied and potential pine snake habitat.

In 2001, the Service provided funds, through the Private Stewardship Grant Program to a private landowner for habitat restoration and prescribed burning at CMAs on several tracts of their Bienville Parish property containing a known Louisiana pine snake population. A habitat management plan for those sites was developed, and in August of 2005, that landowner was awarded a \$45,400 Private Stewardship Grant for continued habitat improvement (e.g., longleaf pine restoration) on that same property. Subsequently, that property has been transferred to a new landowner and a Grant Modification to transfer the remaining funds to the present landowner has been executed. Through the use of those grant funds and voluntary investment, those private landowners have converted 177 ha (438 ac) of the Kepler Lake site and 210 ha (518 ac) of the Sandy Lands site to longleaf pine within those CMAs. Furthermore, during early 2011, the present landowner completed prescribed burning of 227 ha (560 ac) at the Kepler Lake site and 259 ha (639 ac) at the Sandy Lands site (Cook 2011, pers. comm.).

The Louisiana Pine Snake Conservation Group consists of representatives from a variety of organizations having an interest in Louisiana pine snake conservation and includes approximately 90 individuals representing State and Federal government, non-profit and private organizations, zoos, academia and private landowners. This group has been holding annual stakeholder meetings since 2003. At those meetings, stakeholders discuss issues and threats to the Louisiana pine snake, identify possible strategies to deal with those threats, report on land management activities beneficial to stability or recovery, and discuss and share successful results. A number of important conservation issues have been discussed at those meetings (many leading to conservation actions), including: (1) the captive propagation program and associated research begun at the Memphis Zoo and expansion of that program to a consortium of AZA institutions; (2) current field research and needs; (3) existing trapping methods and potential enhancements to increase effectiveness; (4) impacts resulting from all-terrain-vehicle (ATV) use on public lands where designated use areas are being employed to concentrate ATV use in areas unlikely to support the Louisiana pine snake; and (5) educational outreach efforts aimed at public acceptance and conservation of reptiles as a natural component of the longleaf pine ecosystem. Five other significant activities have resulted from cooperative efforts of this group's members: (1) completion of a threats assessment (using expert opinion) for the Louisiana pine snake (Wagner et al. 2009b); (2) development and completion of a landscape-scaled resources selection function model (Wagner et al. 2009a); (3) training and experimental testing of a scent dog to assist in survey efforts; (4) initiation of an experimental captive breeding and reintroduction program; and (5) initiation of a DNA microsatellite study leading to a determination of heterozygosity for 16 loci which will help define genetic structure among populations (Kwiatkowski et al. 2010, pp. 1-4).

As a result of discussion during the 2007 Louisiana pine snake stakeholders meeting, the need to better define

threats to the species in order to design improved conservation and management activities was recognized. To address this gap, in 2009, a research team consisting of private and USFS biologists developed a Delphi method survey instrument (matrix) to identify threats, stressors, stressor elements, and stressor element response levels. The matrix was designed to incorporate the traditional five-factor threats criteria used by the Service in species listing under the Endangered Species Act (ESA) as well as the Service's threats assessment guidance. This effort resulted in a "white paper" by Wagner et al. (2009b) that identifies actions needed for each population and measures of success for those actions.

Although expert opinion has provided important insight into edaphic (soil-related) factors and vegetative requirements for the Louisiana pine snake, rigorous habitat models were previously not available. Landscape-scale models of potential and suitable habitat are essential to inform conservation management efforts for this species. To address this gap, in 2009, a research team consisting of private and Forest Service biologists developed a preliminary LRSF model of potential Louisiana pine snake habitat, using available Louisiana pine snake location data to delineate used and available units, and county and parish soil survey data as edaphic factor-independent variables. The research team modeled selection of potential habitat using resource selection functions that estimate the proportionate probability of use of the resource units, which in this case, are soil-type characteristics. The team developed a set of a priori resource-selection function models based on combinations of soil attributes that were expected to influence the snake's use, and have identified the model that best fits the data from that a priori set. Model predictions have been extrapolated across the Louisiana pine snake's historic range, providing a continuous map of the relative probability that an area possesses the edaphic factors selected by Louisiana pine snakes. The team presented their final results at the 2009 Louisiana pine snake stakeholder meeting. The model will be used to determine: (1) if there are areas of preferable habitat within the historic range that have not been adequately surveyed for the Louisiana pine snake; (2) identify focus areas for management, restoration, and reintroduction potential; and (3) quantify the spatial extent and location of Louisiana pine snake habitat within protected lands. Additional Louisiana pine snake distribution data and further refinement of habitat models through collection of suitable herbaceous vegetation and Baird's pocket gopher abundance data are needed to ensure that proactive forest management conducted by the signatories of the CCA is located in areas that are currently occupied by the Louisiana pine snake. The LRSF Model will help guide signatories to focus future trap efforts and manage additional areas of potentially preferable soils that do not currently provide suitable herbaceous ground cover.

Preliminary efforts to train and use a scent dog to conduct Louisiana pine snake surveys have been inconclusive. Future efforts to revisit this survey method will include resolution of practical issues such as establishment of a handler (potentially a consultant) and ownership of the trained dog.

In consideration of the results from the Louisiana pine snake captive breeding program, CCA habitat management activities, the threats assessment and the LRSF model presented at the 2009 stakeholders meeting, an informal committee was formed to develop and implement an experimental reintroduction of the Louisiana pine snake. The project has two goals: (1) demonstrate the feasibility of reintroducing a population to restored habitat using individuals from a captive population; and (2) establishing a viable population in restored habitat. To date, two reintroduction sites have been identified in unoccupied habitat on the Kisatchie National Forest within the historic range, using the LRSF model and site visits. Louisiana pine snakes are being reared in captivity by a consortium of zoos. As of August 2010, the captive-breeding Louisiana pine snake population consisted of 72 individuals (38 males and 34 females) at 21 AZA institutions, which are divided into three groups of snakes separated by their different geographic origins – Bienville Parish, LA; Vernon Parish, LA; and eastern Texas. The Bienville, LA portion of the captive-breeding population consists of 65 individuals (34 males and 31 females) distributed among 21 institutions. The Vernon, LA portion consists of three individuals (one male and two females) at one institution. The Texas portion consists of four individuals (three males and one female) at one institution (Reichling and Schad 2010, p. 1). The reintroduction effort has been implemented (e.g., release, monitoring by radio-telemetry, etc.) by a partnership of cooperating agencies and AZA institutions. Initial reintroduction began in 2010. Three zoos (the Gladys Porter Zoo in Brownsville, TX; the Audubon Zoo in New Orleans, LA; and the Memphis Zoo in Memphis, TN) provided a total of twenty neonates (four clutches) for release. Eleven

individuals were released as neonates shortly after their post-natal shed. The remaining nine individuals are currently being held in Nacogdoches, TX and Memphis, TN. Those snakes will be provided with a heat source throughout the winter and fed as often as they will accept prey. Those snakes are proposed to be released in early April 2011. Estimates are that AZA institutions will produce approximately 50 Louisiana pine snakes for reintroduction in 2011 (Rudolph and Reichling 2010, p. 2).

Kwiatkowski et al. (2010) has developed DNA Microsatellite primers to allow genetic analysis within and between Louisiana pine snake populations. Preliminary results indicate low levels of heterozygosity and lack Hardy-Weinberg equilibrium suggesting that populations are small and isolated.

## **Summary of Threats :**

The Louisiana pine snake is listed as a candidate species, thereby indicating the Service has sufficient information on biological vulnerability and threats to support a proposal to list as endangered or threatened. The summary below indicates that significant threats to the Louisiana pine snake continue to support the ranking as a candidate species.

The primary threats to this species stem from extensive historic habitat losses, coupled with the disruption of natural fire regimes, which have reduced the Louisiana pine snake to seven isolated populations. Several of these remnant populations may be vulnerable to factors associated with low population sizes and demographic isolation such as reduced genetic heterozygosity. The historic and ongoing loss of potential habitat (via fire suppression, conversion to pine plantations, increases in the number and width of roads, and urbanization) on private lands in the matrix between these extant populations reduces the potential for dispersal among remnant populations and the potential for natural re-colonization of vacant suitable habitat patches. Because it is unlikely that corridors linking extant populations will be established, the loss of any extant population is likely to be permanent. Louisiana pine snake populations on Federal lands have received increased management attention (via prescribed burning and thinning) in recent years, and as a result the successional degradation of occupied and potential habitat within these populations has been stabilized or reversed. Nonetheless, not all areas of occupied habitat on Federal lands have received recent prescribed burning, and in the absence of adequate burning Louisiana pine snake habitat becomes degraded via vegetative succession. The largest and perhaps most important extant Louisiana pine snake population exists on private industrial timberland. Although two conservation areas are managed to benefit Louisiana pine snakes on this property, the majority of the occupied habitat between the conservation areas is threatened by land management activities (habitat conversion to short-rotation pine plantations) that are expected to decrease habitat quality.

Additional threats which may occur even within quality Louisiana pine snake habitat include: (1) road mortality; (2) off-road mortality due to all-terrain-vehicle use; (3) mortality from entanglement in erosion control blankets installed in rights-of-way; (4) intentional killing (the public's general dislike for snakes, which also contributes to 1 and 2 above); (5) the loss of demographic viability and increased susceptibility to stochastic environmental factors resulting from small isolated populations; (6) genetic isolation and susceptibility to genetic drift and inbreeding depression resulting from small isolated populations; and (7) the minimal possibility of collection for the pet trade. Finally, the Louisiana pine snake has an extremely low reproductive rate, thereby magnifying the effects of the above listed threats. We find that this species is warranted for listing throughout all its range, and, therefore, find that it is unnecessary to analyze whether it is threatened or endangered in a significant portion of its range.

## **For species that are being removed from candidate status:**

\_\_\_\_\_ Is the removal based in whole or in part on one or more individual conservation efforts that you determined met the standards in the Policy for Evaluation of Conservation Efforts When Making Listing Decisions(PECE)?

## Recommended Conservation Measures :

- Improve assessment of Louisiana pine snake population status by continuing to explore better survey techniques facilitated by the Landscape-scale Resource Selection Function Model and potential use of a trained scent dog;
- Enhance existing and/or establish longleaf pine forests within occupied and potential Louisiana pine snake habitat;
- Within occupied and potential Louisiana pine snake habitat, reduce and or remove midstory component within pine forest stands to a level that allows maintenance by fire;
- Within occupied and potential Louisiana pine snake habitat, implement a prescribed fire program (typical 3 to 5-year intervals once the forest is in a management condition) to reduce the midstory forest component and maintain the herbaceous layer;
- Within occupied and potential Louisiana pine snake habitat, reduce timber stand density through selective thinning to allow insolation to the ground layer thereby enhancing the herbaceous layer and pocket gopher habitat;
- Within occupied and potential Louisiana pine snake habitat, manage timber primarily for ecological restoration or on longer rotations and for higher end products such as saw timber and poles;
- Within occupied and potential Louisiana pine snake habitat, limit off-road vehicular use and consider road closures;
- Provide conservation education to the general public, and to managers, hunters and other recreational users to avoid killing or otherwise impacting snakes in the wild;
- Educate collectors and other members of the public on the rarity of the Louisiana pine snake and the need to refrain from removing the species from the wild;
- Continue captive breeding and experimental reintroduction program to enhance populations within suitable habitat actively managed for Louisiana pine snake.

## Priority Table

Magnitude	Immediacy	Taxonmomy	Priority
<b>High</b>	Imminent	Monotypic genus	1
		Species	2
		Subspecies/Population	3
	<b>Non-imminent</b>	Monotypic genus	4
		<b>Species</b>	<b>5</b>
		Subspecies/Population	6
Moderate to Low	Imminent	Monotype genus	7
		Species	8
		Subspecies/Population	9
	Non-Imminent	Monotype genus	10
		Species	11
		Subspecies/Population	12

## Rationale for Change in Listing Priority Number:

## **Magnitude:**

The Louisiana pine snake has been reduced to seven extant populations; all of these populations have been impacted by habitat loss and all require active habitat management. Most Louisiana pine snake habitat loss occurred historically and much of the habitat that remains has been degraded for reasons discussed previously. On public lands (53 percent of the potential current range) Louisiana pine snake habitat is receiving increased management emphasis. Much of this land area is now being managed on longer rotations (i.e., 70+ years) where silvicultural prescriptions include midstory removal, thinning and prescribed fire. That type of silviculture is well-suited to maintaining and/or enhancing Louisiana pine snake habitat. All extant populations are currently isolated and fragmented by the historic and ongoing loss of potential habitat (via fire suppression, conversion to pine plantations, increases in the number and width of roads, and urbanization) that has occurred on the private lands between the seven remnant populations. The loss of potential habitat in the intervening areas reduces the potential for dispersal among remnant populations and the potential for natural re-colonization of vacant suitable habitat patches. Several of the remnant populations may be vulnerable to decreased demographic viability or other factors (e.g., low genetic heterozygosity) associated with low population sizes and demographic isolation. In addition, a large portion of potentially occupied habitat for one extant Louisiana pine snake population is threatened by activities (habitat conversion to short-rotation pine plantations) that are expected to decrease habitat quality.

The potential threats to a large percentage of extant Louisiana pine snake populations leads us to conclude that the magnitude of the threats to this species remain high.

## **Imminence :**

The loss in quantity and quality of longleaf pine habitat is the most significant historical threat to the Louisiana pine snake. Several localized threats continue to impact extant Louisiana pine snake populations and their habitat. As noted above, many current silvicultural practices on private lands degrade habitat quantity and quality for the Louisiana pine snake. However, voluntary management is maintaining and improving habitat conditions within portions of occupied habitat for two extant Louisiana pine snake populations on private land. Management by signatories of the CCA is currently stabilizing and improving the quality of habitat for Louisiana pine snake populations on Federal lands.

Based on the assessment of the status of the seven extant populations, two populations appear to be large enough and to occur on sufficient amounts of appropriately-managed habitat as to be considered stable. The five other populations each have uncertain statuses: three because of apparently low population sizes, one because of apparently low population size coupled with low amounts of suitable habitat, and one because of threats resulting from activities that are expected to decrease habitat quality. Three extant Louisiana pine snake populations appear to be both small and isolated. These populations are therefore vulnerable to the loss of demographic viability and to increased susceptibility to stochastic environmental factors (e.g., weather events, disease). Although these remnant populations are intrinsically vulnerable and thus threatened by these factors, it is not known if they are presently actually facing these threats. To the extent that conversion to pine plantation degrades habitat quality, the Bienville population is likely experiencing ongoing habitat degradation in the lands outside of the Core Management Areas. The condition of occupied or potentially occupied habitat in the other six extant populations appears to be stable or improving due to active management.

Based on the above facts, we conclude that threats to the Louisiana pine snake population as a whole are non-imminent.

  Yes   Have you promptly reviewed all of the information received regarding the species for the purpose of determination whether emergency listing is needed?

## **Emergency Listing Review**

No   Is Emergency Listing Warranted?

No, most of the longleaf pine habitat of the Louisiana pine snake has been destroyed for decades and much of the remaining habitat has been degraded. Louisiana pine snake habitat loss is continuing at a slower rate than in the past, and is being stabilized or reduced on Federal lands and some private lands. Voluntary, pro-active management actions to restore degraded habitat, reduce threats, and maintain Louisiana pine snake populations are being conducted on public lands in accordance with the ongoing 2003 CCA and a private landowner has successfully competed for a Private Stewardship Grant to directly address Louisiana pine snake conservation on a private landholding. Private landowners are also demonstrating interest in the CCA through their presence and involvement at annual stakeholder meetings in 2003 - 2010.

We do not believe that emergency listing is warranted at this time.

### **Description of Monitoring:**

Trapping surveys for the Louisiana pine snake continue to occur within limited sections of occupied habitat for some (4 out of 7) extant Louisiana pine snake populations. The occupied habitat of the Kisatchie, LA population has likely never been trapped and the Bienville, LA and Sabine, TX populations have not been trapped since 2009 (Rudolph 2011, pers. comm.). Results of those surveys are discussed at annual Louisiana pine snake meetings. Starting in 2010, limited monitoring by radio-telemetry was conducted by the USFS for Louisiana pine snakes released through the captive breeding and reintroduction programs (Rudolph and Reichling 2010, p.1). Reintroduced snakes were also fitted with pit-tags and pit-tag recorders were deployed at the release sites (Rudolph and Reichling 2010, p.1). Those recorders could potentially generate limited dispersal and survival data for some of those reintroduced snakes.

### **Indicate which State(s) (within the range of the species) provided information or comments on the species or latest species assessment:**

Louisiana, Texas

### **Indicate which State(s) did not provide any information or comment:**

none

### **State Coordination:**

The Louisiana pine snake is included as a species of concern in the Wildlife Action Plans for both Louisiana and Texas.

### **Literature Cited:**

Bonnet, X., G. Naulleau, and R. Shine. 1999. The dangers of leaving home: dispersal and mortality in snakes. *Biological Conservation* 89:39-50.

Bridges, E.L. and S.L. Orzell. 1989. Longleaf pine communities of the West Gulf coastal Plain. *Natural Areas Journal* 9:246-253.

Boundy, J. 2008. Louisiana Department of Wildlife and Fisheries, Baton Rouge, LA, e-mail to U.S. Fish and Wildlife Service, Lafayette, LA. March 13, 2008.

Candidate Conservation Agreement (CCA) for the Louisiana pine snake (*Pituophis ruthveni*). 2003. 33 p.

- Collins, J.T. and T.W. Taggart. 2002. Standard common name and current scientific names for North American amphibians, turtles, reptiles, and crocodylians. Fifth Edition. Publication of the Center for North American Herpetology, Lawrence, KS. iv + 44 pp.
- Conant, R. and J.T. Collins. 1991. A field guide to reptiles and amphibians of eastern and central North America, third edition. Houghton Mifflin Company, Boston, MA. 450 pp.
- Cook, B. 2001. Hancock Forest Management, Hancock Timber Management Group, Mansfield, LA, e-mail to Michael Sealy, U.S. Fish and Wildlife Service, Lafayette, LA. April 11, 2011.
- Crother, B.I. (Editor) 2000. Scientific and standard English names of amphibians and reptiles of North America north of Mexico, with comments regarding confidence in our understanding. SSAR Herpetological Circular 29, Shoreview, MN. 82 pp.
- Ealy, M.J., R.R. Fleet, and D.C. Rudolph. 2004. Diel activity patterns of the Louisiana pine snake *Pituophis ruthveni* in eastern Texas. *Texas Journal of Science* 56:383-394.
- Frost, C.C. 1993. Four centuries of changing landscape patterns in the longleaf pine ecosystem. Pgs. 17-43 In: S.M. Hermann (ed.). *Proceedings of the Tall Timbers Fire Ecology Conference, No. 18, The longleaf pine ecosystem: ecology, restoration and management*. Tall Timbers Research Station, Tallahassee, FL.
- Gregory, B. 2008a. Louisiana Department of Wildlife and Fisheries, Baton Rouge, LA, e-mail to U.S. Fish and Wildlife Service, Lafayette, LA. March 14, 2008.
- Gregory, B. 2008b. Louisiana Department of Wildlife and Fisheries, Baton Rouge, LA, e-mail to U.S. Fish and Wildlife Service, Lafayette, LA. March 10, 2008.
- Himes, J.G. 2000. Burrowing ecology of the rare and elusive Louisiana pine snake, *Pituophis ruthveni* (Serpentes: Colubridae). *Amphibia-Reptilia* 22:91-101.
- Himes, J.G., L.H. Hardy, D.C. Rudolph, and S.J. Burgdorf. 2002. Growth rates and mortality of the Louisiana pine snake. *Journal of Herpetology* 36:683-687.
- Himes, J.G., L.H. Hardy, D.C. Rudolph, and S.J. Burgdorf. 2006. Movement patterns and habitat selection by native and repatriated Louisiana pine snakes *Pituophis ruthveni*: Implications for conservation. *Herpetological Natural History* 9:103-116.
- Hunter, W.C., D.A. Buehler, R.A. Canterbury, J.L. Confer, and P.B. Hamel. 2001. Conservation of disturbance-dependent birds in eastern North America. *Wildlife Society Bulletin* 29:440-455.
- Kwiatkowski, M.A., C.M. Somers, R.G. Poulin, D.C. Rudolph, J. Martino, T.D. Tuberville, C. Hagen and S.L. Lance. 2010. Development and characterization of 16 microsatellite markers for the Louisiana pine snake, *Pituophis ruthveni*, and two congeners of conservation concern. Uncorrected proof submitted for review to *Conservation of Genetic Resources*. February 10, 2010. 4 pp.
- Pierce, J. 2008. U.S. Forest Service, Nacogdoches, TX, e-mail to U.S. Fish and Wildlife Service, Lafayette, LA U.S. Fish and Wildlife Service, Lafayette, LA. March 8, 2008.
- Pierce, J. 2009. U.S. Forest Service, Nacogdoches, TX, e-mail to Ben Thatcher, U.S. Fish and Wildlife Service, Lafayette, LA. March 9, 2009.
- Reichling, S.B. 1990. Reproductive traits of the Louisiana pine snake (*Pituophis melanoleucus ruthveni*) (Serpentes: Colubridae). *The Southwestern Naturalist* 35:221-222.

- Reichling, S.B. 1995. The taxonomic status of the Louisiana pine snake (*Pituophis melanoleucus ruthveni*) and its relevance to the evolutionary species concept. *Journal of Herpetology* 29:186-198.
- Reichling, S.B. 2008. Louisiana pine snake species survival plan. Unpublished report submitted to the U.S. Fish and Wildlife Service, Lafayette, LA. 15 pp. + tables and appendices.
- Reichling, S.B., D.C. Rudolph, D. Ferri, and C. Baker. 2008. Relative abundances of snakes in Louisiana industrial forest, with special emphasis on *Pituophis ruthveni*. Unpublished report submitted to the U.S. Fish and Wildlife Service, Lafayette, LA. 11 pp. + tables.
- Reichling, S.B. 2008. Memphis Zoo, Memphis, TN, e-mail to U.S. Fish and Wildlife Service, Lafayette, LA. March 14, 2008.
- Reichling, S.B. and K. Schad. 2010. Draft population analysis and breeding and transfer plan; the Louisiana pine snake (*Pituophis ruthveni*) AZA species survival plan program. Unpublished draft report. 9 pp. + tables and appendices.
- Rodriguez-Robles, J.A., and Jesus-Escobar, J.M. 2000. Molecular systematics of new world gopher, bull, and pinesnakes (*Pituophis*: Colubridae), a transcontinental species complex. *Molecular Phylogenetics and Evolution* 14:35-50.
- Rudolph, D.C. 2000. Habitat quality at historical Louisiana pine snake localities. Unpublished report submitted to U.S. Fish and Wildlife Service, Jackson, MS. 11 pp. + tables and appendices.
- Rudolph, D.C. 2008a. U.S. Forest Service, Nacogdoches, TX, e-mail to U.S. Fish and Wildlife Service, Lafayette, LA . March 10, 2008.
- Rudolph, D.C. 2008b. U.S. Forest Service, Nacogdoches, TX, telephone conversation with Ben Thatcher, U.S. Fish and Wildlife Service, Lafayette, LA. March 10, 2008.
- Rudolph, D.C. 2008c. U.S. Forest Service, Nacogdoches, TX, e-mail to U.S. Fish and Wildlife Service, Lafayette, LA. March 11, 2008.
- Rudolph, D.C. 2011. U.S. Forest Service, Nacogdoches, TX, e-mail to Michael Sealy, U.S. Fish and Wildlife Service, Lafayette, LA. March 9, 2011
- Rudolph, D.C., and S.J. Burgdorf. 1997. Timber rattlesnakes and Louisiana pine snakes of the west gulf coastal plain: Hypotheses of decline. *Texas Journal of Science* 49:111-122.
- Rudolph, D.C., and S.B. Reichling. 2010. Louisiana pine snake reintroduction – 2010 annual update. Unpublished report submitted to U.S. Fish and Wildlife Service, Lafayette, LA. 2 pp.
- Rudolph, D.C., S.J. Burgdorf, J.C. Tull, M. Ealy, R.N. Conner, R.R. Schaefer, R.R. Fleet. 1998. Avoidance of fire by Louisiana pine snakes, *Pituophis melanoleucus ruthveni*. *Herpetological Review* 29:146-148.
- Rudolph, D.C., S.J. Burgdorf, R.N. Conner, and R.R. Schaefer. 1999. Preliminary evaluation of the impact of roads and associated vehicular traffic on snake populations in eastern Texas. Pages 129-136 in G.L. Evink, P. Garrett and D. Zeigler (eds.), *Proceedings of the Third International Conference on Wildlife Ecology and Transportation*, FL-ER-73-99, Missoula, Montana.
- Rudolph, D.C., S.J. Burgdorf, R.N. Conner, C.S. Collins, D. Saenz, R.R. Schaefer, T. Trees, C.M. Duran, M. Ealy, J.G. Himes. 2002. Prey Handling and Diet of Louisiana Pine Snakes (*Pituophis ruthveni*) and Black

- Pine Snakes (*P. Melanoleucus lodingi*), with Comparisons to other Selected Columbrid Snakes. *Herpetological Natural History* 9(1), 2002:57-62.
- Rudolph, D.C., S.J. Burgdorf, and R.R. Schaefer, R.N. Conner, and R.W. Maxey. 2006. Status of *Pituophis ruthveni* (Louisiana pine snake). *Southeastern Naturalist* 5:463-472.
- Shively, S. 1999. Louisiana Department of Wildlife and Fisheries, Baton Rouge, LA, telephone message to U.S. Fish and Wildlife Service, Lafayette, LA . March 16, 1999.
- Smith, T. 2008. TimberSTAR SW Managers, LA, telephone conversation with Ben Thatcher, U.S. Fish and Wildlife Service, Lafayette, LA. March 7, 2008.
- Stull, O.G. 1929. The description of a new subspecies of *Pituophis melanoleucus* from Louisiana. *Occasional Papers of Museum of Zoology, University of Michigan* 205:1-3.
- U.S. Department of the Army. 2008. Joint Readiness Training Center (JRTC) and Fort Polk (FP) Regulation 210-18. Headquarters, Joint Readiness Training Center and Fort Polk. 15 pp.
- U.S. Department of the Army. 2010. Presentation at the 2010 Louisiana Pine Snake Stakeholders Meeting. Ellen Trout Zoo, Lufkin, TX. August 19, 2010.
- USDA Forest Service Manual (FSM) 2600 – Fish, Wildlife, and Sensitive Plant Habitat Management. 2002.
- USDA Forest Service. 2007. Presentation at the 2007 Louisiana Pine Snake Stakeholders Meeting. Natchitoches Events Center, Natchitoches, LA. August 22, 2007.
- USDA Forest Service. 2009. Presentation at the 2009 Louisiana Pine Snake Stakeholders Meeting. Natchitoches Events Center, Natchitoches, LA. August 20, 2009.
- USDA Forest Service. 2010. Presentation at the 2010 Louisiana Pine Snake Stakeholders Meeting. Ellen Trout Zoo, Lufkin, TX. August 19, 2010.
- U.S. Fish and Wildlife Service (USFWS). 2007. Species assessment and listing priority assignment form for the black pine snake *Pituophis melanoleucus lodingi*. 13 pp.
- Vandeventer, T.L. and R.A. Young. 1989. Rarities of the longleaf: the black and Louisiana pine snakes. *Vivarium* 1:32-36.
- Wagner, R.O., D. Hightower, J. Pierce, D/C. Rudolph, and R. Schaefer. 2009a. Landscape-scaled resource selection functions of potential Louisiana pine snake (*Pituophis ruthveni*) habitat. Unpublished report submitted to the U.S. Fish and Wildlife Service, Lafayette, LA. 19 pp.
- Wagner, R.O., D. Hightower, B. Thatcher, and D.C. Rudolph. 2009b. Using expert opinion to assess threats to Louisiana pine snake (*Pituophis ruthveni*) populations. Unpublished report submitted to the U.S. Fish and Wildlife Service, Lafayette, LA. 18 pp.
- Webb, J.K., B.W. Brook, and R. Shine. 2002. What makes a species vulnerable to extinction? Comparative life-history traits of two sympatric snakes. *Ecological Research* 17:59-67.
- Williams, A.A. and J.E. Cordes. 1996. *Pituophis ruthveni* (Louisiana pine snake). *Herpetological Review* 27:35.
- Young, R.A. and T.L. Vandeventer. 1988. Recent observations on the Louisiana pine snake, *Pituophis*

**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.

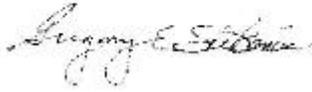
Approve:



06/22/2011

Date

Concur:



10/07/2011

Date

Did not concur:

\_\_\_\_\_

\_\_\_\_\_ Date

Director's Remarks: