

# 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:

04/23/2014

## 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 to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status

Taxon not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species

Range is no longer a U.S. territory

Insufficient information exists on biological vulnerability and threats to support listing

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

\_\_\_ More abundant than believed, diminished threats, or threats eliminated.

## **Petition Information**

\_\_\_ Non-Petitioned

X 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 within Region 4, 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 the Louisiana pine snakes 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:** Beauregard, LA, Bienville, LA, Jackson, LA, Natchitoches, LA, Rapides, LA, Sabine, LA, Vernon, LA, Angelina, TX, Hardin, TX, Houston, TX, Jasper, TX, Nacogdoches, TX, Newton, TX, Polk, TX, Sabine, TX, San Augustine, TX, Trinity, TX, Tyler, TX, Wood, TX
- **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, Cherokee, TX, Jasper, TX, Nacogdoches, TX, Newton, TX, Shelby, TX, Wood, TX
- **Countries:** United States

## **Land Ownership:**

Current potentially occupied habitat in Louisiana and Texas is estimated to be approximately 58,496 hectares (ha) or 144,549 acres (ac); 54 percent (31,846 ha or 78,694 ac) occurring on public lands (Kisatchie and Angelina National Forests and U.S. Department of Defense (DOD) lands at Fort Polk, Louisiana) and 46 percent (27,390 ha or 67,683 ac) in private and state ownership (Table 1).

## **Lead Region Contact:**

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## **Biological Information**

### **Species Description:**

Pine snakes (genus *Pituophis*) are large, short-tailed, non-venomous, powerful constricting snakes with keeled scales, a single anal plate (the scale covering the cloaca) and disproportionately small heads (Conant and Collins 1991, pp. 201-202). Their snouts are pointed and they are good burrowers. The Louisiana pine snake (*P. ruthveni*) has a buff to yellowish background color with dark brown to russet dorsal blotches covering its total length (Vandeventer and Young 1989, p. 35; Conant and Collins 1991, p. 203). The belly of the Louisiana pine snake is unmarked or boldly patterned with black markings. The Louisiana pine snake is variable in both coloration and pattern, but a characteristic feature is that its body markings are always conspicuously different at opposite ends of its body. Blotches run together near the head, often obscuring the background color, and then become more separate and well-defined towards the tail. Typically, there are no noticeable head markings, although rarely a light bar or stripe may occur behind the eye. The length of adult Louisiana pine snakes ranges from 122 to 142 centimeters (cm) (48 to 56 inches (in)) (Conant and Collins 1991, p. 203). The largest reported specimen was 178 cm (5.8 feet (ft)) long (Davis 1971, p. 145; Conant and Collins 1991, p. 203).

### **Taxonomy:**

The Louisiana pine snake is a member of the Class Reptilia, Order Squamata, Suborder Serpentes, and Family Colubridae. Stull (1929, pp. 2-3) formally described the Louisiana pine snake as a pine snake subspecies (*P. melanoleucus ruthveni*) based on two specimens taken in Rapides Parish, Louisiana. Reichling (1995, p. 192) reassessed this snakes taxonomic status and concluded that the Louisiana pine snake was geographically isolated and phenotypically distinct, and thus a valid evolutionary species. The Louisiana pine snake has subsequently been accepted as a full species, *P. ruthveni* (Crother 2000, p. 69; Rodriguez-Robles and Jesus-Escobar 2000, p. 46; Collins and Taggart 2002, p. 33). 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 (*Pinus palustris*) ecosystem that historically existed in Louisiana and Texas. Louisiana pine snake habitat consists of sandy, well-drained soils in open pine forest (especially longleaf-pine savanna), a sparse midstory, and well-developed herbaceous ground cover dominated by grasses and forbs (Rudolph and Burgdorf 1997, p. 117). Abundant ground-layer herbaceous vegetation is important for the Louisiana pine snake and their primary prey, the Bairds pocket gopher (*Geomys breviceps*). These fire-climax park-like conditions are created and maintained by recurrent low-intensity ground fires that occur on a 3 to 5 year return interval. In the absence of recurrent fire, suitable Louisiana pine snake habitat conditions are lost due to vegetative succession. Using radio-telemetry in Bienville Parish, Louisiana, Himes (1998, p. 17) recorded native Louisiana pine snakes (nine adults and one juvenile) most frequently in pine forests (56 percent), followed by pine plantation (23 percent) and clear-cuts (9 percent). 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).

Bairds pocket gophers create the burrow systems in which Louisiana pine snakes are most frequently found (Rudolph and Conner 1996, p. 2; Rudolph and Burgdorf 1997, p. 117; Himes 1998, p. 42; Rudolph *et al.* 1998, p. 146; Rudolph *et al.* 2002, p. 62; 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). Up to 90 percent of radio-tagged Louisiana pine snake relocations have been underground in pocket gopher burrow systems, and movement patterns are typically from one pocket gopher burrow system to another. In Louisiana, habitat selection by Louisiana pine snakes seemed to be determined by the abundance and distribution of pocket gophers and their burrow systems (Himes 1998, p. 41). Active Louisiana pine snakes occasionally utilized debris, logs, and low vegetation as temporary surface shelters, (Rudolph and Burgdorf 1997, p. 117; Himes 1998, p. 26; Ealy *et al.* 2004, p. 386); however, most Louisiana pine snakes disturbed on the surface retreated to nearby burrows (Rudolph and Burgdorf 1997, p. 117). Louisiana pine snakes also minimally used decayed or burned stumps, or nine-banded armadillo (*Dasyus novemcinctus*) burrows as underground refugia (Ealy *et al.* 2004, p. 389).

Bairds pocket gopher abundance is dependent upon the availability of herbaceous groundcover and loose, sandy soils. Because a rich, herbaceous ground layer requires a high degree of solar penetration onto the forest floor, the amount of herbaceous vegetation is related to canopy cover. Himes (1998, p. 43) found that pocket gopher abundance was associated with a low density of trees and an open canopy, which allowed greater sunlight, more herbaceous understory growth, and better forage for pocket gophers.

Louisiana pine snake sexual maturity is attained at an approximate length of 120 cm (4 ft) and an age of approximately three years (Himes *et al.* 2002, p. 686). The Louisiana pine snake is oviparous, with a gestation period of about 21 days (Reichling 1988, p. 77), followed by 60 days of incubation. Having the smallest clutch size (3 to 5) of any North American colubrid snake, the Louisiana pine snake is limited by a remarkably low reproductive rate (Reichling 1990, p. 221). However, the Louisiana pine snake produces the largest eggs (generally 12 cm (5 in) long and 5 cm (2 in) wide) of any U.S. snake (Reichling 1990, p. 221). It also produces the largest hatchlings reported for any North American snake, ranging 45 to 55 cm (18 to 22 in) in length, and up to 107 grams (g) in weight (Reichling 1990, p. 221). Captive Louisiana pine snakes can live over 30 years, but females have not reproduced beyond the age of 18 years (Reichling 2008a, p. 4, Appendix A).

Himes *et al.* (2006, p. 107) found that the Louisiana pine snake had an average home range size of 33.2 ha (82 ac) (range 6.5 to 108 ha (16 to 267 ac)). Himes (1998, p. 18) found that adult males had larger home ranges (58.7 ha (145 ac)) than females (14 ha (25 ac)) and juveniles (5.5 ha (13 ac)). Due to its rarity, secretive nature, and preference for occupying pocket gopher burrow systems, 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.

Louisiana pine snakes appeared to be most active March-May and September-November (especially November) and least active December-February and summer (especially August) (Himes 1998, p. 12). Louisiana pine snakes were observed by Ealy *et al.* (2004, p. 391) to be semi-fossorial and essentially diurnal. Ealy *et al.* (2004, p. 390) documented that the species spent 59 percent of daylight hours (sunrise to sunset) below ground and moved an average of 163 meters (m) (541 ft) per day. Furthermore, Louisiana pine snakes in east Texas were relatively immobile (i.e., moved less than 10 m (33 ft)) on 54.5 percent of days monitored and all recorded movements occurred during daytime (Ealy *et al.* 2004, p. 391). Adult males in Louisiana moved an average of 150 m (495 ft) daily, adult females 106 m (348 ft), and juveniles 34 m (112 ft) (Himes 1998, p. 18).

Additionally, Bairds pocket gophers are the primary prey of the Louisiana pine snake (Himes 2000, p. 97; Rudolph *et al.* 2002, p. 58) comprising an estimated 53 percent of available individual prey records (Rudolph *et al.* 2012, p. 243), although the species has also been known to eat eastern moles (*Scalopus aquaticus*), cotton rats (*Sigmodon hispidus*), deer mice (*Peromyscus* sp.), harvest mice (*Reithrodontomys* sp.), and turtle (probably *Trachemys scripta*) eggs (Rudolph *et al.* 2002, p. 59, Rudolph *et al.* 2012, p. 244).

## **Historical Range/Distribution:**

The Louisiana pine snake historically occurred in portions of northwest and west-central Louisiana and extreme east-central Texas (Conant 1956, p. 19). This area coincides with an isolated, and the most westerly, occurrence of the longleaf pine ecosystem and is situated west of the Mississippi River. Most of the sandy longleaf pine-dominated savannas believed to be the preferred habitat of 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 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).

The U.S. Forest Service (USFS), Southern Research Station (SRS), Wildlife Habitat and Silviculture Laboratory in Nacogdoches, Texas, has compiled and maintains a historical records database of all known Louisiana pine snake locations (excluding telemetry data). According to that database, 247 occurrence records of 223 individual Louisiana pine snakes have been verified from 1927 through November 20, 2013 (excluding reintroductions) (Pierce 2013 unpub. data). Based on this database, there are historical records 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), although the Wood County, Texas specimens are being reevaluated (Figure 1). Previous Louisiana pine snake reports that are not included in this database are as follows: single records for Calcasieu and Jefferson Davis Parishes in Louisiana (Williams and Cordes 1996, p. 35), considered suspect by the Natural Heritage Division of the Louisiana Department of Wildlife and Fisheries (Shively 1999 pers. comm.); a single record from Cherokee County, Texas, which was erroneous (Pierce 2009 in litt.); single records from Montgomery and Walker Counties in Texas re-classified as *Pituophis catenifer* (Pierce 2008 in litt.); two records from Rapides Parish, Louisiana and one from Caldwell County, Texas from the 1960s considered not verifiable (Pierce 2013 pers. comm.).

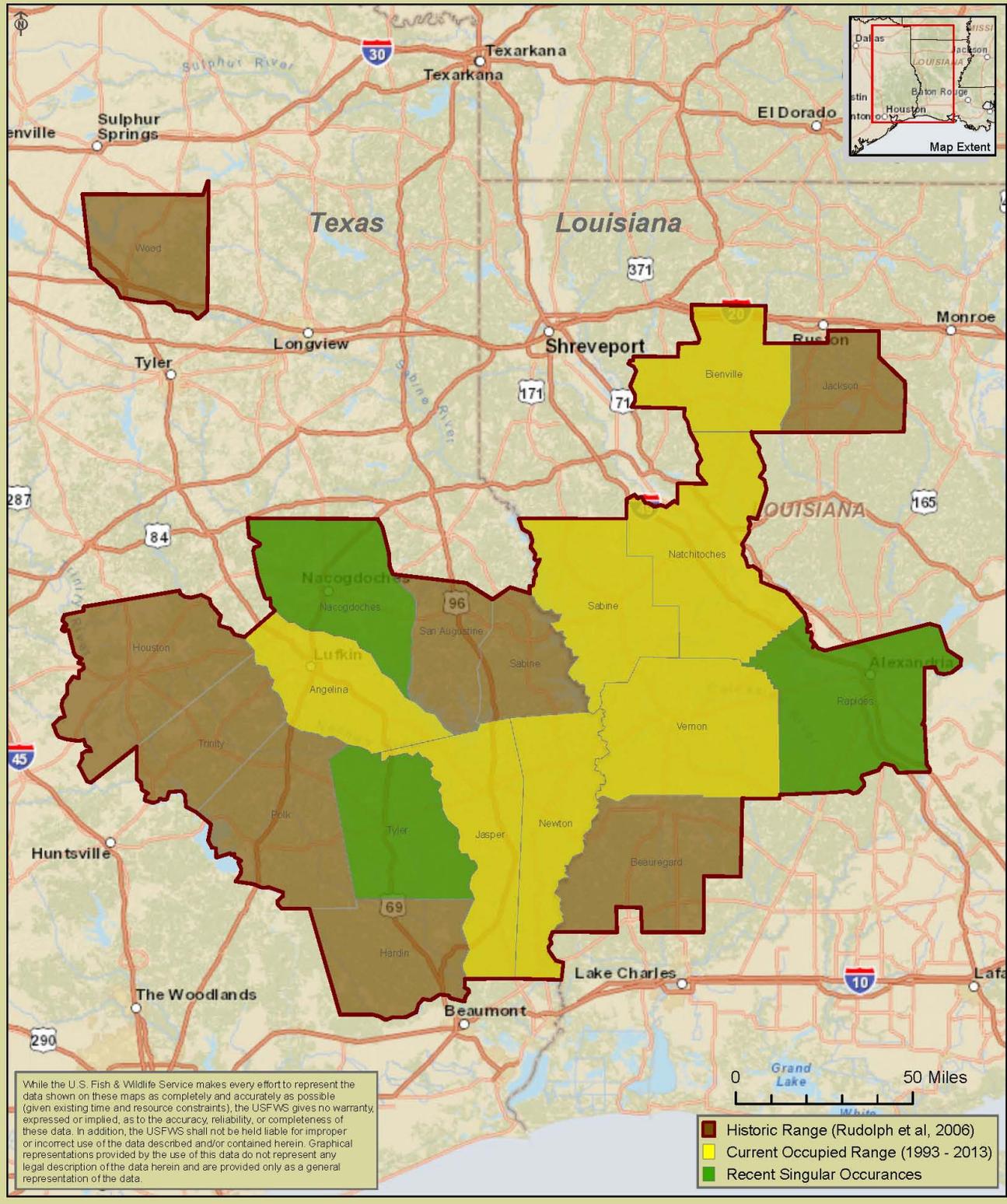


Figure 1. Historic and current parishes of Louisiana and counties of Texas with documented Louisiana pine snake occurrence (based on Rudolph *et al*, 2006, and the Historic Records Database (Pierce, unpub. data 2013)).

## Current Range Distribution:

Currently, trapping (which is expensive and labor intensive) is the only available method for surveying Louisiana pine snake populations. Since 1990, Louisiana pine snake trapping has been conducted by the USFS, the DOD (Fort Polk and the Joint Readiness Training Center (JRTC)), the Memphis Zoo, and the Louisiana Department of Wildlife and Fisheries (LDWF). In total, trapping from throughout the historic range of the Louisiana pine snake has resulted in 91 unique individual captures during 365,923 trap days (1993-2013) (Pierce 2013 unpub. data). Supported by range-wide trapping results and the historical records database, Rudolph *et al.* (2006, p. 467-469) 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 had been extirpated from significant portions of its historical range (USFS 2011 pers. comm.) (three parishes (Beauregard, Jackson, and Rapides) in Louisiana and eight counties (Hardin, Houston, Nacogdoches, Polk, Sabine, San Augustine, Trinity, and Wood) in Texas). Rudolph *et al.* (2006, p. 467-469) determined that six occupied areas were in existence at the time of publication. In 2007, an additional Louisiana pine snake occupied area was observed on the Kisatchie District of the Kisatchie National Forest (KNF) in Louisiana. Based on 2014 analysis of occurrence records of counties or parishes with multiple observations since 1993, six natural, potentially extant, Louisiana pine snake populations occur in four parishes (Bienville, Natchitoches, Sabine, and Vernon) in Louisiana and three counties (Angelina, Jasper, and Newton) in Texas (Figure 1). An additional reintroduction feasibility-study population has been established in Grant Parish, Louisiana.

Although single observations were not used to establish known occupied areas, additional observations of single individuals have been made in one Louisiana parish and two Texas counties. A single 1994 observation of a Louisiana pine snake crossing a road may indicate that an additional remnant population persists in Tyler County, Texas. Similarly, a single observation of a Louisiana pine snake found dead along a road in 2001 indicates that the current population in Natchitoches Parish may extend into extreme northwestern Rapides Parish, Louisiana. In 2013, an adult female Louisiana pine snake was obtained and is being kept at the Audubon Zoo in New Orleans, LA. That individual was captured as a juvenile in 2008 in Nacogdoches County near Garrison, Texas, suggesting that enough Louisiana pine snakes were present at that site for recruitment as recent as 5 years ago (Reichling 2013a, in litt.).

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) stated that 70 percent (26 of 37) of the localities on public lands met their criteria as excellent or good condition, whereas only 33 percent (27 of 81) of the localities on private lands met their criteria as 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)). The distribution of Louisiana pine snakes within the current range is further 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). 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.

Potentially occupied habitat of the Louisiana pine snake (based upon 1993-2013 occurrence data) is primarily concentrated on public lands (DOD lands at Fort Polk and Peason Ridge, Louisiana and the Kisatchie and Angelina National Forests) and privately-owned industrial timberlands in Louisiana and Texas. However, due to the expense and time required for trapping and the only recently available predictive habitat model (Wagner *et al.* 2009a), sufficient Louisiana pine snake surveys have not occurred in all areas of potential habitat 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.

To estimate the size of occupied ranges, all Louisiana pine snake records ( $n = 154$ ) from 1993 to 2013 containing location data were plotted in a Geographic Information System (GIS). Using ArcMap (Version

10.2.1), a minimum convex polygon (MCP) was drawn around clusters of records, and a 1.0 kilometer (km) (0.6 mile (mi)) buffer was drawn around each MCP, resulting in an Occupied Habitat MCP (OHMCP). The OHMCP was buffered to accommodate the fact that trap locations were not placed on the landscape with the intent of delineating population boundaries. A 1.0 km (0.6 mi) buffer was used because telemetry data indicate this is a reasonable approximation of the area that a Louisiana pine snake uses during 1 or more years (Rudolph 2008a in litt.).

On March 7, 2014, a webinar was conducted to elicit expert opinion regarding alternative methodologies to improve OHMCP estimation. From those discussions, the USFWS has determined that the boundaries of estimated OHMCPs will be based on data and methodology that meets the following criteria:

Include all verified occurrence records:

1. Obtained during an 11-year span that ends with the last trapping season prior to drawing the OHMCP. An 11-year range is a conservative estimate based upon best expert opinion that Louisiana pine snake generational turnover in captive-born and held Louisiana pine snakes has been observed to be a maximum of 11.3 years (Marti 2014, in litt.);
2. Obtained after 1993 (when trapping effort began) and prior to the 11-year span:
  - When trapping effort has not been conducted within 1.0 km (0.6 mi) of the record (no supporting information available to inform us of the current status of occurrence at these locations) for a total of 5 years;
  - When trapping effort has been conducted within 1.0 km (0.6 mi) of the record (Rudolph 2008a, in litt.) and new occurrence has been documented within the 11-year span;

Not include occurrence records (including chance observations such as road sightings or vehicle-caused mortality):

1. Obtained prior to when Louisiana pine snake trapping effort commenced (1993);
2. Obtained before the 11-year span when trapping for Louisiana pine snakes was conducted within 1.0 km (0.6 mi) of those records and produced no captures after 5 years of trap effort.

That methodology uses records (including non-trap occurrence) obtained over a period of intense surveys during the estimated generational time of Louisiana pine snakes in captivity. However, some records (n=15, from 1993 to the 11-year span) that could still potentially be in an area occupied by the species, where habitat attributes have remained similar or improved since observed occurrence, are not used for this estimation of occupied range because significant trapping efforts have not produced any additional records in that area. The purpose of the resulting OHMCPs is to match proactive habitat management activities to areas most likely to be currently occupied by the Louisiana pine snake.

Because trapping results are functions of trap location selection, trap success, and true presence or absence, trapping data only approximates Louisiana pine snake use of an area, but is the best available estimate. Using this method, the OHMCP is an underestimation if undocumented Louisiana pine snakes occur outside of the current estimated boundaries. Conversely, the OHMCP can be an overestimation because the actual amount of suitable habitat (based on soils, pocket gopher abundance, and vegetation) within each polygon is currently unknown.

Through the implementation of the methods described above, the following OHMCPs have been delineated in 2014:(1) the Bienville, LA OHMCP located on privately owned industrial timberlands in Bienville Parish, and a small amount of State lands; (2) the Kisatchie, LA OHMCP located on USFS lands (the Kisatchie Ranger District of the KNF in Natchitoches Parish); (3) the Peason Ridge, LA OHMCP located on DOD lands (Fort Polk and the JRTC in Vernon and Sabine Parishes) and a small amount of private lands; (4) the Fort Polk/Vernon, LA OHMCP located on DOD lands (Fort Polk and the JTRC), USFS lands (the Vernon

Unit/Calcasieu District of the KNF), and a small amount of private lands in Vernon Parish; (5) the Scrappin Valley, TX OHMCP located on privately owned industrial timberlands in Newton County; (6) the Angelina, TX OHMCP located on USFS lands (the southern section of the Angelina National Forest in Angelina and Jasper Counties) and private lands; and (7) the Catahoula, LA Reintroduction OHMCP located on USFS lands (the Catahoula Ranger District of the KNF in Grant Parish). Utilizing the methods described above to estimate OHMCPs in 2014, the Winn Ranger District of the KNF in Natchitoches Parish, LA and the Sabine National Forest in Sabine County, TX are no longer considered occupied.

Using the methodology described above to estimate the extant Louisiana pine snake occupied areas, those OHMCPs occur on 12,744 ha (31,491 ac) of DOD lands, 19,102 ha (47,203 ac) of USFS lands, 84 ha (206 ac) of State lands, and 27,306 ha (67,477 ac) of private lands (Table 1).

Table 1. Land ownership (hectares (acres)) of estimated Louisiana pine snake occupied ranges (OHMCPs).

State	Population	U.S. Forest Service	Department of Defense	State Lands	Private	Total for Population
<b>Louisiana</b>	Bienville			84 (206)	24,638 (60,855)	24,722 (61)
	Kisatchie	1,553 (3,838)				1,553 (3,838)
	Peason Ridge		1,927 (4,761)		12 (29)	1,939 (4,790)
	Fort Polk/Vernon	14,886 (36,785)	12,214 (30,182)		36 (88)	27,136 (67,055)
<b>Louisiana Total</b>		17,473 (43,178)	14,141 (34,943)	84 (206)	27,567 (68,119)	59,265 (146,446)
<b>Texas</b>	Scrappin' Valley				2,047 (5,057)	2,047 (5,057)
	Angelina	3,837 (9,482)			574 (1,418)	4,411 (10,900)
	<b>Texas Total</b>	3,837 (9,482)			2,621 (6,475)	6,458 (15,957)
<b>Total Ownership</b>		19,102 (47,203)	12,744 (31,491)	84 (206)	27,306 (67,477)	58,496 (144,549)

Wagner *et al.* (2009a, p. 15) developed a preliminary Landscape-scaled Resource Selection Functions Model of Potential Louisiana Pine Snake Habitat (LRSF-Model) using available Louisiana pine snake location data to more accurately delineate used and available units, and county and parish soil survey data as edaphic factor-independent variables. Selection of preferred habitat using resource selection functions that estimate the proportionate probability of use of the resource units, which in this case are soil-type characteristics, were modeled. A set of *a priori* resource-selection function models based on combinations of soil attributes that were expected to influence the Louisiana pine snake's use were developed and the model that best fits the data from that *a priori* set was identified. Model predictions have been extrapolated across the Louisiana pine snakes historic range, providing a continuous map of the relative probability that an area possesses the particular soil conditions selected by Louisiana pine snakes (Table 2). As part of the updated Louisiana Pine Snake Candidate Conservation Agreement (CCA) (USFWS 2013, p. 24), Louisiana Pine Snake Habitat Management Units (LPS HMUs) were delineated on Federal land that is owned by CCA Cooperators (USFS and DOD) (Table 2). LPS HMUs were identified by using the LRSF-Model in conjunction with professional land-manager expertise to delineate areas that have the best potential for providing preferential habitat to Louisiana pine snakes. LPS HMU boundaries were established regardless of known occupancy, current herbaceous ground cover, midstory, or canopy conditions, or Bairds pocket gopher density. LPS HMU boundaries are now used to guide conservation priorities and analyze habitat management actions (see

Population Estimates/Status) to better assess the effect of management on potentially preferable habitat that Louisiana pine snakes are more likely to select.

Table 2: Total hectares (acres) (U.S. Department of the Army 2010 pers. comm., USFS 2011 pers. comm., U.S. Department of the Army 2013 unpub. data) of Louisiana pine snake habitat on Federal lands: OHMCP: the area within the population boundary polygon based on occurrence data; LPS HMU: area based upon the LRSF-Model and professional expertise that is managed to maintain or improve habitat; LRSF-Model: Landscape Resources Selection Function Model (Wagner *et al.*, 2009a).

<b>OHMCP</b>	<b>Federal Property</b>	<b>OHMCP on Federal Property</b>	<b>LRSF-Model within Federal Property</b>	<b>LPS HMU</b>	<b>LRSF-Model within LPS HMU</b>
<b>Kisatchie, LA</b>	Kisatchie Dist. (KNF)	647 (1,599)	11,904 (29,416)	14,614 (36,114)	7,004 (17,308)
<b>Peason Ridge, LA</b>	Peason Ridge	1,966 (4,857)	3,446 (8,535)	4,559 (11,265)	2,085 (5,151)
<b>Fort Polk/Vernon, LA</b>	Fort Polk	10,778 (26,634)	16,306 (40,292)	11,751 (29,037)	9,072 (22,418)
<b>Fort Polk/Vernon, LA</b>	Vernon Unit (KNF)	13,878 (34,294)	33,869 (83,691)	24,842 (61,387)	19,647 (48,549)
<b>Angelina, TX</b>	Angelina NF	3,837 (9,482)	N/A (N/A)	9,793 (24,200)	6,586 (16,274)
<b>Sabine, TX</b>	Sabine NF	0 (0)	N/A (N/A)	4,641 (11,469)	2,142 (5,293)
	Winn Dist. (KNF)	0 (0)	19,882 (49,129)	16,411 (40,553)	8,296 (20,500)
	Evangeline Unit (KNF)	0 (0)	N/A (N/A)	19,590 (48,407)	16,782 (41,470)
<b>Catahoula, LA Reintroduction</b>	Catahoula Dist. (KNF)	740 (1,828)	N/A (N/A)	23,227 (57,394)	23,227 (57,394)

## Population Estimates/Status:

The Louisiana pine snake is recognized as one of the rarest snakes in North America (Young and Vandeventer 1988, p. 203; Himes *et al.* 2006, p. 114). The Louisiana pine snake was classified in 2007 as endangered on the IUCN (World Conservation Union) Red List of Threatened Species (version 3.1; <http://www.iucnredlist.org/>). Because basic life history information is lacking for this species and current sampling methodology cannot determine population density, no estimates exist regarding the acreage or population size necessary to support a viable Louisiana pine snake population. Without management, the current and future status of the Louisiana pine snake will be influenced by the likelihood that all remnant Louisiana pine snake populations will remain demographically and genetically isolated into the future.

Due to its semi-fossorial habits, rarity, and secretive nature, Louisiana pine snakes are difficult to locate and trap, even in areas where they are known to occur (Ealy *et al.* 2004, p. 384). To date, most Louisiana pine snake records have been from trapping and opportunistic sightings. Trapping effort data are used to estimate trap success (i.e., the number of trap days required to catch one snake) for each population. Trapping has provided important information on Louisiana pine snake occurrences. However, population densities cannot be reliably estimated from trapping data because mark-recapture analyses cannot be conducted without sufficient numbers of Louisiana pine snake recaptures. Although that data are very limited and inconclusive,

they suggest that this type of trap effort captures the individuals that frequent or use the area in the immediate vicinity of those traps and may not detect other individuals within the larger study area other than when snakes are seasonally moving longer distances (Gregory 2013b in litt.). For example, during the 2007-2009 trapping period of the Kepler Lake area of the Bienville, LA OHMCP, LDWF marked all trap-captured coachwhips (*Masticophis flagellum*) and racers (*Coluber constrictor*) which are more common and mobile than Louisiana pine snakes and did not catch unique individuals after a short period of time (Gregory 2013b in litt.). Radio-telemetry observations by Ealy *et al.* (2004, p. 390-391) found that Louisiana pine snakes are primarily diurnal, and are relatively immobile, which further limits extrapolation of trap data for estimation of population size or density. Consequently, no estimates of Louisiana pine snake population densities exist. However, the current, best available indices of estimated Louisiana pine snake abundance are trap success and other types of occurrence records. Although we report these indices for each OHMCP, it is undeterminable how these metrics relate to true population size.

With the exception of the Fort Polk/Vernon and Peason Ridge populations, most populations have shown a decline in trap success through time. Despite continued effort, some populations have not experienced trap success or new individual occurrence records for many years. For this reason, the Winn Ranger District of the KNF portion of the Bienville, LA OHMCP and the former Sabine, TX OHMCP are no longer considered occupied and have been removed. Trapping efforts (all provided by Pierce 2013 unpub. data) and management actions are presented for each OHMCP below.

(1) The Bienville, LA OHMCP: Based on historic trap success and occurrence records (44 observations (including trap recaptures) from 2003 to 2013), 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; Pierce 2013 unpub. data). While trap success varies annually, the trap success in this area has been consistently better than for any other population overall. Although, trapping from a previous effort on the Winn District portion of this population between 2000 to 2001 provided two captures (in addition to one recapture), trap efforts in the same area from 2004 to 2013 have produced zero captures in 7,525 trap days and is now regarded as unoccupied. Within the current OHMCP, nearly all records for this population (44 captures during 29,470 trap days during 2000 to 2013; 1:670) have occurred within the Kepler Lake, Sandylands, and Plantation areas of a 12,353 ha (30,525 ac) parcel of privately-owned industrial timberland (Reichling *et al.* 2008, p. 1, Pierce 2013 unpub. data). Trapping on that private timberland has only recently resumed in 2012 after cessation in 2009. The Kepler Lake area of that parcel has produced the best trap success anywhere in the Louisiana pine snakes range (Table 3). Consequently, Reichling *et al.* (2008, p. 10) believed this site was critical for the preservation of this species.

Table 3: Trapping success of effort within the Bienville, LA OHMCP

Site	Years	Trap Days/Capture	Captures (Unique Individuals)	Trap Days
<b>Kepler Lake</b>	1995-1996	233	7	1,629
	2004-2005	434	8	3,470
	2007-2009	438	9	3,939
	2012-2013	844	4	3,376
<b>Sandylands</b>	2004-2005	1,735	2	3,470
	2007-2009	1,268	3	3,803
	2012-2013	997	2	1,994
<b>Plantation</b>	2004-2005	1,735	2	3,470
	2007-2009	3,650	1	3,650
	2012-2013	1,671	1	1,671

Within that privately-owned timberland described above, two disjunct Louisiana pine snake Core Management Areas (CMAs) (the 344 ha (851 ac) Kepler Lake site and the 348 ha (859 ac) Sandylands site)

have been voluntarily established by the landowners. These two CMAs have been enrolled by LDWF into the Natural Areas Registry which provides habitat management assistance to the landowner. These sites are managed for the Louisiana pine snake with thinning, longleaf pine restoration, targeted herbicide use, and prescribed burning. Based on information from the current landowner (Cook 2011 in litt.), 51 percent (177 ha (438 ac)) of the Kepler Lake CMA and 60 percent (210 ha (518 ac)) of the Sandylands CMA have been converted to longleaf pine since 2001. Through a U.S. Fish and Wildlife Service (USFWS) Private Stewardship Grant, the present landowner completed prescribed burning of 66 percent (227 ha (560 ac)) of the Kepler Lake CMA and 74 percent (259 ha (639 ac)) of the Sandylands CMA during early 2011 (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.). Most of the timberlands surrounding those CMAs are managed with intensive silvicultural practices. 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 concluded 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 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, this parcel of timberland was purchased by a Timber Investment Management Organization (TIMO) in 2006. In 2008, that parcel was transferred to another TIMO, adding to the uncertainty of future management on this private parcel. In cooperation with other partners, the USFWS has been working towards committed conservation actions (possibly through a Candidate Conservation Agreement with Assurances (CCAA)) that would maintain or improve conditions in the CMAs and increase the amount of suitable habitat available on a larger area of that parcel. At this time, no commitment, agreement, or easement exists to maintain or expand the quality of habitat on that parcel.

Despite habitat improvements on some of the CMAs, this population has experienced a large amount of historic habitat loss and degradation as a result of conversion to pine plantation management throughout this almost completely privately owned OHMCP. Additionally, trapping effort on the privately owned Kepler Lake/Sandylands region of this population has only recently resumed in 2012 (not trapped 2009 through 2011). The recent additional captures highlight the need to continue trapping within this OHMCP to strengthen the assessment of this important population. Consequently, the status of this Louisiana pine snake population remains uncertain.

(2) The Kisatchie, LA OHMCP: Two relatively recent Louisiana pine snake occurrence records (one non-capture sighting (2003) and one hand-capture (2007)) exist for this population. No Louisiana pine snakes were captured during 12,011 trap days (1997 to 2003) on the Kisatchie District of the KNF. However, 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). Trapping resumed within this population in 2012, and continued in 2013, in that suitable habitat and no captures occurred in 5,169 trap-days (Pierce 2013 unpub. data).

Active habitat management for the red-cockaded woodpecker (RCW) (*Picoides borealis*) and the Louisiana pine snake occur within the OHMCP of this population. Nearly all (98 percent) of the Louisiana pine snake OHMCP and 72 percent of the LPS HMU was prescribe-burned during 2011 to 2013 (USFS 2014a unpub. data) (Table 4). Additionally, commercial timber harvest (thinning) occurred on 280 ha (691 ac) of the LPS HMU in 2013 (Table 4). Ongoing habitat loss is not a threat to this population. The existence of two Louisiana pine snake sightings since 2003 is encouraging, but cannot be compared to historical trap success because only the 2012-2013 trapping effort occurred in potential suitable habitat. Consequently, the status of this population is uncertain. Due to the lack of trapping effort from 2003 until 2012, assessment of this population remains difficult. Continued trapping efforts in potentially preferable habitat (as indicated by the LRSF-Model and pocket gopher presence), will continue to strengthen the assessment of this population.

Table 4: Total hectares (acres) of Louisiana pine snake habitat managed on the Kisatchie Ranger District/KNF in the OHMCP and LPS HMU.

	Area	Growing Season Rx Burning (2013)	Dormant Season Rx Burning (2013)	Total Rx Burning (2013)	Total Rx Burning During 2011-2013	Stocking Reduction (Thinning) (2013)
<b>OHMCP</b>	647 (1,599)	0 (0)	155 (383)	155 (383)	634 (1,567)	0 (0)
<b>LPS HMU</b>	14,615 (36,114)	1,305 (3,225)	2,828 (6,989)	4,133 (10,214)	10,511 (25,973)	280 (691)

(3) The Peason Ridge, LA OHMCP: Six occurrence records (from 2003 to 2013, all observed after 2005) exist for this population; one of which was a non-trap sighting. The trapping effort for the last 5 years (2009 to 2013 (8,446 trap days)) produced four captures, one in 2010, two in 2012, and one in 2013, with a success rate of 1:2,112 (Pierce 2013 unpub. data). Trap success for this population has improved throughout the trapping era (2006 to 2013) and demonstrates the strong influence of just one additional capture of this species to trap success rate within any timeframe.

On DOD lands, 37 percent of the OHMCP and 71 percent of the HMU was prescribe-burned during 2011 to 2013 (Table 5). None of the LPS HMU was thinned during 2013 (U.S. Department of the Army 2014 unpub. data). However, a large portion of potentially occupied habitat occurs within an artillery impact range which is known to experience wildfires, but the frequency is unknown. An estimated 226 ha (559 ac) of the OHMCP and 833 ha (2059 ac) of the HMU was burned by wildfires in 2011 to 2013 (U.S. Department of the Army 2014 unpub. data). Active habitat management for the RCW and the Louisiana pine snake occurring at this site has stabilized or increased the amount of preferable habitat that exhibits suitable vegetative characteristics. Trap success is comparatively moderate; however, overall occurrence records continue to remain low. Additionally, the LRSF-Model suggests that significantly less potentially preferable habitat exists at Peason Ridge than was previously estimated. 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 ongoing to strengthen the assessment of this population.

Table 5: Total hectares (acres) of Louisiana pine snake habitat managed on the Peason Ridge Training Area (Fort Polk and the JRTC) in the OHMCP and LPS HMU.

	Area	Growing Season Rx Burning (2013)	Dormant Season Rx Burning (2013)	Total Rx Burning (2013)	Total Rx Burning During 2011-2013	Stocking Reduction (Thinning) (2013)
<b>OHMCP</b>	1,977 (4,886)	362 (895)	198 (490)	560 (1,385)	735 (1,816)	0 (0)
<b>LPS HMU</b>	4,559 (11,265)	2,060 (5,090)	864 (2,136)	2,924 (7,226)	3,214 (7,943)	0 (0)

(4) The Fort Polk/Vernon, LA OHMCP: Twenty-two occurrence records from 2003 to 2013 including four non-trap sightings and four trap-recaptures exist for this population. Trap success for this population over the last 5 years (2009 to 2013) is estimated to be 1:2,625 (8 unique individual captures out of 21,003 trap days) which includes all recent unsuccessful surveying on the Vernon Unit of the KNF. Since 2003, no captures have occurred on the Vernon Unit. Excluding trapping on the Vernon Unit, DOD observed a trap success rate over the last 5 years of 1:1,959 (8 unique individual captures during 15,672 trap days) on DOD property (Pierce 2013 unpub. data).

Fort Polk prescribe-burned all of the OHMCP and the LPS HMU on DOD land during 2011 to 2013. In 2013,

32 ha (87 ac) was thinned on the OHMCP, but none of the LPS HMU was thinned (U.S. Department of the Army 2014 unpub. data) (Table 6).

On the Vernon Unit/Calcasieu Ranger District of the KNF, 99 percent of the OHMCP and 97 percent of the LPS HMU was prescribe-burned from 2011 to 2013 (Table 6). Approximately 222 ha (548 ac) of the OHMCP and 236 ha (583 ac) of the LPS HMU was thinned in 2013 (USFS 2014b unpub. data). Extensive occupied and preferable Louisiana pine snake habitat exists at this site (Table 2), and active habitat management for the RCW and the Louisiana pine snake has stabilized or increased the amount of habitat that has suitable vegetative characteristics. The relatively moderate trap success, large number of occurrence records and 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 ongoing to strengthen the assessment of this population.

Table 6: Total hectares (acres) of Louisiana pine snake habitat managed in the Fort Polk/Vernon Unit/KNF in the OHMCP and LPS HMU.

	Area	Growing Season Rx Burning (2013)	Dormant Season Rx Burning (2013)	Total Rx Burning (2013)	Total Rx Burning During 2011-2013	Stocking Reduction (Thinning) (2013)
<b>Fort Polk OHMCP</b>	10,778 (26,634)	522 (1,289)	2,157 (5,329)	2,678 (6,618)	10,778 (26,634)	32 (87)
<b>Fort Polk LPS HMU</b>	11,751 (29,037)	929 (2,295)	2,650 (6,549)	3,579 (8,843)	11,751 (29,037)	0 (0)
<b>Vernon OHMCP</b>	13,878 (34,294)	1,926 (4,760)	3,648 (9,015)	5,575 (13,775)	13,676 (33,793)	222 (548)
<b>Vernon LPS HMU</b>	24,842 (61,387)	2,210 (5,461)	6,725 (16,618)	8,935 (22,079)	24,019 (59,352)	236 (583)

(5) The Scrappin Valley, TX OHMCP: On this private land, five occurrence records during 2003 to 2013 (all since 2005) exist for this population; however, two of those were road mortalities, two were removed from the wild for captive breeding, and one was sighted but not captured. During the last 5 years (2009 to 2013), no trap success has occurred during 15,628 trap days within this population. The most recent trap capture at this site was in 2008. During trapping efforts on this land from 1995 to 1997, five captures occurred during 2,128 trap days with a success rate of 1:426, demonstrating a reduction of trap success at this site (Pierce 2013 unpub. data).

In 2013, the 4,538 ha (11,214 ac) Scrappin Valley Hunting Preserve, which was owned by a single commercial timber management company, was sold and split amongst numerous smaller owners. The LRSF-Model indicated that nearly all of the former Preserve contains potentially preferable habitat (USFS 2010 pers. comm.). A contiguous 769 ha (1,900 ac) parcel was obtained by a single individual and contains the majority of that Preserve managed by the previous owner to enhance habitat for the RCW (enrolled in an RCW Safe Harbor Agreement) and the Louisiana pine snake (Allen 2014 in litt.). In early 2014, 320 ha (790 ac) was prescribe-burned by the new owner. A USFWS Partners for Fish and Wildlife Grant will provide funding for further habitat improvement on portions of that parcel (West Scrappin Valley) including 42 ha (103 ac) of longleaf pine restoration (planting, mechanical, and chemical site preparation) with at least three prescribed burns over a 10-year period, chemical control of midstory on 117 ha (290 ac) of existing longleaf pine dominated stands, and Louisiana pine snake trap construction, rehabilitation and monitoring (Reid 2014 in litt.). The new landowner intends to prescribe burn one-half to one-third of the entire 769 ha (1,900 ac) parcel annually (Reid 2014 in litt.). The majority of the remaining potential habitat on the former Preserve

surrounding this population has historically been fire suppressed and is currently viewed as unsuitable for the Louisiana pine snake (Rudolph 2008b pers. comm.). That land has been purchased by a single timber management company which has been approached about voluntary conservation actions that could benefit the Louisiana pine snake on that parcel. Despite Louisiana pine snake occurrences as recent as 2008, and proactive habitat management by the former and current private landowner, the lack of recent trap success when compared to trap success in the 1990s suggests that this population is vulnerable to decreased demographic viability or stochastic environmental factors due to prolonged minimal suitable habitat availability. Consequently, the status of this population is uncertain. Currently, trap effort in potentially preferable habitat (as indicated by the LRSF-Model and pocket gopher presence) continues to strengthen the assessment of this population.

(6) The Angelina, TX OHMCP: Seven occurrence records during 2003 to 2013 exist for this population. Four were unique trap captures; one was a trap recapture and one was hand-caught alive on a road but both were removed from the wild for captive breeding. Additionally, one previously captured and pit-tagged individual was found dead on a road in 2009. From 2009 to 2013, no unique trap captures have occurred within this population during 16,277 trap days. The most recent unique individual trap capture at this site was in 2007. However, a recapture did occur within this population as recently as 2012 and that individual was removed from the wild for captive breeding. Trap success rates have shown a steady decline throughout the effort period: from 1992 to 1997, success rate was 1:652 (2 captures during 1,303 trap days); during 1998 to 2005, success rate was 1:3,420 (2 captures during 6,840 trap days); and during 2007 to 2012, success rate was 1:5,305 (3 captures during 15,916 trap days). However, all trap effort within this population produced only a total of seven unique individual Louisiana pine snakes since the 1990s (27,656 trap days) (Pierce 2013 unpub. data).

Active habitat management for the RCW and the Louisiana pine snake occurs within RCW HMAs and the LPS HMU at this site. The Angelina National Forest prescribe-burned 87 percent of the OHMCP and 88 percent of the LPS HMU during 2011 to 2013 (Table 7). No thinning of OHMCP or HMA habitat occurred during 2013 (USFS 2014c unpub. data). Despite a 2009 road-kill and 2012 trap recapture record, and large amount of potentially occupied and preferable habitat under active management, trap success rates have declined since the 1990s. However, this population has never had large numbers of snakes observed within any time period other than the years 1995 (n=4) and 2007 (n=4) (Pierce 2013 unpub. data). The 2012 recapture of an individual first captured in 2007 suggests that habitat conditions within that site were adequate to support that snake for the past 5 years. Consequently, the status of this population remains uncertain. Therefore, trap effort in different potentially preferable habitat (as indicated by the LRSF Model and pocket gopher presence) than what is currently trapped would strengthen the assessment of this population.

Table 7: Total hectares (acres) of Louisiana pine snake habitat managed on the Angelina National Forest in the OHMCP and LPS HMU.

	Area	Growing Season Rx Burning (2013)	Dormant Season Rx Burning (2013)	Total Rx Burning (2013)	Total Rx Burning During 2011-2013	Stocking Reduction (Thinning) (2013)
<b>OHMCP</b>	4,411 (10,900)	887 (2,193)	792 (1,957)	1,679 (4,150)	3,827 (9,457)	0 (0)
<b>LPS HMU</b>	9,793 (24,200)	1,573 (3,888)	791 (1,957)	2,364 (5,845)	8,586 (21,216)	0 (0)

(7) The Catahoula, LA Reintroduction OHMCP: In total, 44 captive-bred Louisiana pine snakes have been released into the wild at the Catahoula Ranger District of the KNF (11 in 2010, 15 in 2011, 3 in 2012, and 15 in 2013) (Reichling 2013b, in litt.; Pierce 2013, unpub. data). Detection of released snakes is occurring within this OHMCP through monitoring of deployed Automated PIT Tag Recorders (APTRs) and trapping. As of

August 2013, nine released snakes have been detected alive at least 2 months post-release including four that have been detected alive greater than, or just less than, 2 years post release. One snake has been detected twice (849 days (2.3 years (yr)) after release), one snake has been detected four times (649 days (1.8 yr) after release), and two snakes have been detected five times (657 days (1.8 yr) after release and 762 days (2.1 yr) after release) (Smith 2013 in litt.).

Active habitat management for the RCW and the Louisiana pine snake occurs within RCW HMAs and the LPS HMU at this site. The Catahoula Ranger District prescribe-burned 33 percent of the OHMCP and 53 percent of the LPS HMU during 2011 to 2013 (Table 8). No thinning of OHMCP or HMA habitat occurred during 2013. In 2013, 32 ha (87 ac) was thinned on the OHMCP and approximately 443 ha (1,095 ac) of the LPS HMU was thinned (USFS 2014d unpub. data).

Table 8: Total hectares (acres) of Louisiana pine snake habitat managed on the Catahoula Ranger District/KNF in the Reintroduction OHMCP and LPS HMU.

	Area	Growing Season Rx Burning (2013)	Dormant Season Rx Burning (2013)	Total Rx Burning (2013)	Total Rx Burning During 2011-2013	Stocking Reduction (Thinning) (2013)
<b>OHMCP</b>	740 (1,828)	0 (0)	120 (297)	120 (297)	242 (599)	35 (87)
<b>LPS HMU</b>	23,227 (57,394)	286 (707)	3,656 (9,034)	3,942 (9,741)	12,319 (30,441)	~443 (~1,095)

**Captive-Breeding Population:** As of March 2013, the captive-breeding Louisiana pine snake population consists of 87 individuals (43 males and 44 females) at 22 Association of Zoos and Aquariums (AZA) accredited institutions and 3 partner institutions, which are divided into 3 groups of snakes separated by their different geographic origins Bienville Parish, LA; Vernon Parish, LA; and eastern Texas (Reichling and Schad 2010, p. 1; Reichling 2012, p. 1; Reichling 2013b in litt.).

## Threats

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

To maintain suitable habitat conditions for the Louisiana pine snake, active, continuous forest management is required. On private property, existing potential habitat continues to be lost or degraded (albeit at a considerably slower rate than that which occurred historically), or is being maintained in a degraded condition that is not considered optimal for Louisiana pine snakes. Historically open pine habitats containing dense herbaceous vegetation have been converted and maintained as densely-stocked, closed canopy, off-site industrial pine plantations that are harvested by clear-cut on short rotations (less than 40 years). Based on trapping surveys and location records, Rudolph *et al.* (2006, p. 470) concluded that areas managed with these intensive silvicultural practices do not support viable Louisiana pine snake populations. Furthermore, landscape scale fragmentation caused by short-rotation silviculture has created and is maintaining isolated Louisiana pine snake populations.

The disruption of natural fire regimes, due to fire suppression and inadequate, infrequent prescribed burning, is the leading factor responsible for the degradation of the small amount of remaining longleaf pine forest (Rudolph and Burgdorf 1997, p. 118), and may represent one of the greatest threats to existing Louisiana pine snake habitat quality in recent years (Rudolph 2000, p. 7). In the absence of frequent and effective fires, upland pine savannah ecosystems rapidly develop a mid-story of hardwoods and off-site species which suppress or eliminate any herbaceous understory. Since the presence of pocket gophers is directly related to

the extent of herbaceous vegetation available to them, their population numbers and distribution decline as such vegetation declines. The resulting reduction of pocket gophers and their distribution directly impacts the number and distribution of Louisiana pine snakes. The use of prescribed burning is heavily reduced on private timberlands because of the expense of liability insurance, legal liability, the planting of off-site pine species which have a reduced tolerance to fire, limited funds and personnel, and smoke management issues.

Industrial pine plantations containing off-site pine species are often managed with herbicides instead of prescribed burning. Most of these forests have sparse and poorly structured understory plant communities, an early successional trait that is present throughout the rotation, rendering them generally unsuitable for pocket gophers. Herbicide-use may alter the composition and/or density of the ground cover vegetation in a way that causes pocket gopher decline thus affecting Louisiana pine snake numbers as well (Rudolph and Burgdorf 1997, p. 118). In addition, the increasing trend towards the divestiture of industrial forest lands in the Southeastern U.S. complicates establishing public-private partnerships and long-term forest management agreements.

The Bienville Parish, LA population of Louisiana pine snakes, the largest extant population (Reichling *et al.* 2008, p. 10), primarily occurs on private industrial forest land. Most of this industrial forest has been converted to short-rotation loblolly pine plantations. Although the broadcast application of herbicides has been restricted in select plantations, those sites are currently managed with clear-cutting at 25-year harvest rotations and the use of targeted herbicides instead of prescribed burning (Smith 2008 pers. comm.). Two separate Louisiana pine snake CMAs are being beneficially managed (via longleaf pine restoration, prescribed burning, and understory control) for the Louisiana pine snake. Conversion of forests outside of the CMAs to short-rotation loblolly pine plantations may result in a decrease in the suitability of these surrounding areas as Louisiana pine snake habitat (Rudolph *et al.* 2006, p. 470), thus the Louisiana pine snake populations on the CMAs will become fragmented. If isolation occurs, and neither CMA is large enough to support a viable Louisiana pine snake population, the long-term persistence of Louisiana pine snakes will be at risk (Reichling *et al.* 2008, p. 10). However, Louisiana pine snakes have been found within loblolly pine plantations outside of the CMAs (Reichling *et al.* 2008, p. 6). The recent buying and selling of many Bienville properties by TIMOs adds additional uncertainty regarding the future land-use priorities on these sites. The current landowner of the CMAs, through a USFWS Private Stewardship Grant, conducted habitat improvements that benefit the Louisiana pine snake on the two CMAs (i.e., prescribed burning and midstory control). Representatives from the current TIMO containing the CMAs and several other large industrial timber landowners attended the 2009, 2010, 2012, and 2013 Louisiana pine snake stakeholders meetings and implementation of habitat management on those two CMAs is ongoing. Nonetheless, the 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, no formal conservation agreement exists for any privately-owned habitat occupied by this population. Furthermore, the Bienville OHMCP is located in 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 is being affected by those activities.

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). 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. These factors have limited the development of healthy ground layer herbaceous vegetation in some areas. However, since the 2003 signing of the CCA for the Louisiana Pine Snake between the USFWS, the USFS, DOD (Fort Polk and the JRTC), Texas Parks and Wildlife Department (TPWD), and the LDWF (USFWS 2003, pp. 30), extensive beneficial habitat management (prescribed burning and thinning) within occupied and potential Louisiana pine snake habitat has occurred on Federal lands. The increases in the acreages of burning and thinning conducted have improved habitat conditions on many Federal lands that support Louisiana pine snake populations (Rudolph 2008c in litt.). 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 (Reichling 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. The use of the LRSF-Model has helped focus Louisiana pine snake management actions; however, not all areas of occupied Louisiana pine snake habitat or areas that have been identified by the LRSF-Model as potentially preferable Louisiana pine snake habitat have received recent beneficial management.

An updated CCA for the Louisiana Pine Snake between the USFWS, USFS, Natural Resources Conservation Service (NRCS), DOD (Fort Polk and the JRTC), TPWD, LDWF, and the AZA (USFWS 2013, pp. 71) was finalized and signed in 2013. This agreement updates, supersedes, and improves upon the 2003 CCA and is based upon current habitat threats, implemented management actions, and significant new information derived from research, threats assessments, and habitat modeling that were not available in 2003. Specifically, the updated CCA utilizes the newest and best information currently available to focus specific actions that directly influence the impact of the specifically identified threats within habitat that is preferable to the Louisiana pine snake. However, the updated CCA does not address threats from habitat loss on any specific private land, only private land activities performed by NRCS.

As a result of the CCA and the updated CCA, significantly improved beneficial management of Louisiana pine snake habitat is occurring on Federal lands. However, the widespread disruption of natural fire regimes, fragmentation, inadequate understory management and short-rotation, densely planted, off-site pine plantation silviculture on most of the preferable Louisiana pine snake habitat on private lands is a significant threat to the species.

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:**

According to the United Nations Environment Program-World Conservation Monitoring Centre (UNEP-WCMC 2009, p. 17), reportedly captive-bred Louisiana pine snakes were advertised for sale on four German websites and two U.S. breeders were listed on another website. However, current levels of Louisiana pine snake collection to support the commercial captive-bred snake market have not been quantified. Ongoing take of Louisiana pine snakes in Louisiana for commercial, recreational, scientific, or educational purposes is not currently considered a threat (Boundy 2008 in litt.) and there appears to be very little demand for this species by private collectors (Reichling 2008b in litt.). Given the restricted distribution, presumed low population sizes, and low reproductive potential of Louisiana pine snakes, 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 prohibited from non-permitted collection by State law in Texas and Louisiana, 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 current rarity of the Louisiana pine snake make collection of this species difficult (Gregory 2008 in litt.).

In Texas, TPWD has permitted removal from the wild of Louisiana pine snakes captured by permitted scientific researchers to help supplement the low representation of snakes from Texas populations in the AZA-managed captive breeding program. Currently, LDWF has not permitted the removal from the wild of any wild-caught Louisiana pine snakes to add founders to the AZA-managed captive-breeding program. The cumulative impact to wild populations of removal of wild-caught individuals is undeterminable but may present a threat to this species.

Based on our evaluation, we conclude that there is not sufficient information to develop a proposed listing rule for this species due to the overutilization for commercial, recreational, scientific, or educational purposes.

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

Fritzler (2013 pers. comm.) has identified an endoparasitic nematode (*Capillaria* sp.) that occurs in captive and wild Louisiana pine snakes. Current preliminary research is being conducted to determine transmission mechanisms, prevalence, and speciation of that parasite. The impact of that nematode to wild Louisiana pine snakes is unknown, and currently no data suggests that this parasite is a significant threat to this species.

Furthermore, natural predation is not currently considered to be a significant threat to this species.

Based on our evaluation, we conclude that there is not sufficient information to develop a proposed listing rule for this species due to disease or predation.

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

In Texas, the Louisiana pine snake is listed as state threatened and prohibited from unauthorized collection. As of February 2013, unpermitted killing or removal from the wild is prohibited in Louisiana. Collection or harassment of Louisiana pine snakes is prohibited on USFS properties in Louisiana (USFS 2002, p. 1). The capture, removal, or killing of non-game wildlife from Fort Polk and Peason Ridge (DOD lands) is prohibited without a special permit (U.S. Department of the Army 2008, p. 6; U.S. Department of the Army 2013, p. 51). However, those regulations do not protect the habitat of the species which has declined.

Malicious killing of snakes by humans is a significant issue in snake conservation because snakes arouse fear and resentment from the general public (Bonnet *et al.* 1999, p. 40). Intentional killing of black pine snakes (*Pituophis melanoleucus*) by humans along the Gulf Coast has been documented (USFWS 2007, p. 8). The intentional killing of Louisiana pine snakes by humans is likely, but the extent of the impact of this stressor is unknown. The USFWS does not have information related to the implementation, compliance, or enforcement of the existing regulatory mechanisms by the states or federal land managers.

Based on our evaluation, we conclude that there is not sufficient information to develop a proposed listing rule for this species due to the inadequacy of existing regulatory mechanisms.

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

The most significant factor influencing the current status of the Louisiana pine snake is the loss or modification of longleaf and shortleaf pine (*P. echinata*) communities throughout its historic range. Both the quantity and quality of the longleaf pine ecosystem have declined sharply in Louisiana and Texas since European settlement. The loss, degradation, and fragmentation 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 existed as of the late 1980s 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 southern U.S. 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 historic habitat loss (and hence historical Louisiana pine snake population decline), because most of the habitat loss had already occurred by 1935.

The historical loss, degradation, and fragmentation of the longleaf pine ecosystem across the entire Louisiana pine snake historical range have resulted in six naturally extant Louisiana pine snake populations that are isolated and small. Habitat fragmentation on private lands in the matrix between extant populations has essentially eliminated the potential for successful dispersal among remnant populations, as well as the potential for natural re-colonization of vacant or extirpated habitat patches. Currently, the amount of habitat required to support viable Louisiana pine snake populations, and the necessary distribution of this habitat over the landscape, is not known. In addition, we currently do not know the minimum population size required to maintain self-sustaining populations of the Louisiana pine snake. However, small, isolated populations are vulnerable to the threats of decreased demographic viability, increased susceptibility of extirpation from stochastic environmental factors (e.g., weather events, disease), and the potential loss of valuable genetic resources resulting from genetic isolation and subsequent inbreeding depression and genetic drift. Additionally, it is extremely unlikely that habitat corridors linking extant populations will be secured and restored; therefore, the loss of any extant population will be permanent without future reintroduction of captive-bred individuals. While the Louisiana pine snake is vulnerable to the above threats, we do not currently have data to determine the impact of those threats to the genetic viability of the species.

Roads and associated vehicular traffic have been identified as important causes of snake mortality and population declines (Rudolph *et al.* 1999, p. 130; Himes *et al.* 2002, p. 686). Himes *et al.* (2002, p. 686) documented the death of 15 Louisiana pine snakes during their radio-telemetry study in Louisiana and Texas. Three of the 15 (20 percent) deaths could be attributed to vehicle mortality. Roads with moderate to high traffic levels reduce adjacent snake populations by 50 to 75 percent and measurable impacts extend up to 850 m (approximately 0.5 mi) from the roads (Rudolph *et al.* 1999, p. 130). The threat of road mortality may be highest in the Longleaf Ridge Area of the south Angelina National Forest (Compartments 74 through 77, 79 through 92, and south portions of 73 and 78). Off-road vehicle use may also cause significant impacts to the Louisiana pine snake. However, no significant data exists to quantify the impact of off-road vehicle use.

A more recently identified threat for many snake species is entanglement in filamentous mesh (particularly synthetic, non-biodegradable types) used in erosion control blankets (ECBs) installed on pipeline and road construction rights-of-ways and has been documented by Kapfer and Paloski (2011, p. 1). ECBs can result in direct Louisiana pine snake mortality due to entanglement. Rudolph (2011b in litt.) demonstrated that synthetic ECB material caused immediate entanglement and snakes were unable to extract themselves after exposure. Extensive pipeline construction associated with Haynesville shale gas and oil exploration activities, and the subsequent increase in the use of ECBs, is a particular threat to the Bienville, LA population (Rudolph 2011a in litt.).

The Louisiana pine snake has an extremely low reproductive rate, producing a very small clutch of four eggs on average (Reichling 1990, p. 221). The Louisiana pine snakes low fecundity (reproductive output) and low population growth rate magnifies the effect of all other threats and increases the likelihood of local extirpations.

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 :**

In 2003, a CCA for the Louisiana pine snake which includes the USFWS, USFS, DOD, TPWD, and LDWF was completed and conservation actions are 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 species. That CCA also set up a mechanism to exchange information on successful management practices and coordinate research efforts. An updated CCA for the Louisiana Pine Snake between the USFWS, USFS, NRCS, DOD (Fort Polk and the JRTC), TPWD, LDWF, and the AZA (USFWS

2013, pp. 71) was signed in August 2013. This agreement updates, supersedes, and improves upon the 2003 CCA and is based upon current habitat threats, implemented management actions, and significant new information derived from research, threats assessments, and habitat modeling that were not available in 2003. Specifically, the updated CCA utilizes the newest and best information currently available to focus specific voluntary conservation actions that directly influence the impact of the specifically identified threats within habitat that is preferable to the Louisiana pine snake (LPS HMUs). However, the updated CCA does not address threats from habitat loss on any private land other than the activities performed by NRCS.

Federal partners to the CCA manage land representing an estimated 54 percent of occupied Louisiana pine snake habitat. These partners are addressing habitat management needs through proactive 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 area of prescribed burning and thinning that is not directly related to occupied habitat overestimates the benefit of this management to the Louisiana pine snake. Trap efforts are planned for 2014 in areas outside of the currently defined occupied habitat in order to better refine habitat and beneficial management estimates. During 2011 to 2013, cooperating Federal agencies conducted prescribed burning on 29,893 ha (73,866 ac) of OHMCP lands and 101,077 ha (249,766 ac) of LPS HMUs (delineation based upon potentially preferable (LRSF-model) habitat as described in USFWS 2013, p. 24).

Additionally, the USFWS is actively presenting the benefits of CCAAs to willing landowners that possess land within the OHMCPs and LRSF Model habitat that would benefit from such agreements. Two private timber management companies are actively working with the USFWS on potential voluntary conservation actions that could support CCAAs. However, as of April 2014, no private landowners were formal signatories of the CCA or have signed CCAAs or Conservation Easements to benefit the Louisiana pine snake.

In 2001, the USFWS provided funds, through the Private Stewardship Grant Program to a private landowner for habitat restoration and prescribed burning on several tracts of their Bienville Parish property containing the CMAs described above. 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 was transferred to a new landowner and a Grant Modification to transfer the remaining funds to the present landowner was 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 Sandylands 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 Sandylands site (Cook 2011 in litt.).

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 and new research. 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 off-road-vehicle (ORV) use on public lands where designated-use areas are being employed to concentrate ORV 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 groups 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 landscaped 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 USFWS in species listing under the Endangered Species Act as well as the USFWS 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. A modified version of the resulting matrix is incorporated into specific, stressor/response-based actions of the signatories in the 2013 updated CCA (USFWS 2013, App. B).

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 USFS 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 as described above in Current Range/Distribution. The team presented their final results at the 2009 Louisiana pine snake stakeholder meeting. The model is currently being 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 (HMUs); (3) quantify the spatial extent and location of Louisiana pine snake habitat within protected lands; and (4) identify private landowners that control large amounts of preferable habitat to offer CCAAs. Currently, Federal signatories of the CCA report their management actions specifically on HMUs delineated by LRSF Model preferable habitat. Additional Louisiana pine snake distribution data and further refinement of habitat models through collection of suitable herbaceous vegetation and Bairds 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 (HMUs).

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, ownership of the trained dog, and a methodology to detect the accuracy of Louisiana pine snake detectability. Preliminary investigation has begun into the potential viability of working with existing, established, and proven programs that currently train scent dogs. Currently, two separate dog training facilities (one in Louisiana and another in Memphis, TN) have volunteered their time and services to train two new scent dogs. Field assessment of these two attempts to produce Louisiana pine snake scent detection dogs has not yet begun.

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-bred population and (2) establish a viable population in restored habitat. To date, five reintroduction sites have been identified in unoccupied habitat on the Catahoula Ranger District/KNF 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 March 2013, the captive-breeding Louisiana pine snake population consisted of 87 individuals (43 males and 44 females) at 22 AZA institutions and 3 partner institutions, which are divided into 3 groups of snakes separated by their different geographic origins Bienville Parish, LA; Vernon Parish, LA; and eastern Texas (Reichling and Schad 2010, p. 1; Reichling 2012, p. 1; Reichling 2013b in litt.). The reintroduction effort has been implemented (e.g., release, monitoring by radio-telemetry and APTRs, etc.) by a partnership of cooperating agencies and AZA institutions. Initial reintroduction began in 2010.

In 2010, 3 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 19 neonates (4 clutches) for release. Eleven individuals were released as neonates shortly after their post-natal shed (Rudolph and Reichling 2010, p. 2). The remaining eight individuals were held at the USFS Southern Research Station (SRS), the Ellen Trout Zoo in Nacogdoches, TX and the Memphis Zoo. Those snakes were provided with a heat source throughout the winter and fed as often as they accepted prey (head-started). Those eight snakes were released in April 2011. In 2011, 14 neonates were hatched at the Memphis Zoo, Audubon Zoo, and Woodland Park Zoo (Seattle, WA). Seven of those were released in August and September 2011 (Reichling 2012, p.1). Three of the 2011 cohort were head-started and released in May 2012 (Reichling 2013b in litt.). In 2013, an additional 15 head-started Louisiana pine snakes were released. In total, 44 captive-bred Louisiana pine snakes have been released into the wild at the Catahoula Unit of the KNF.

In 2011, biologists representing LDWF and the USFWS presented a training seminar to hunters who lease private land from the TIMO that owns the largest and possibly most important privately-owned portion of the Bienville, LA population. Those biologists also presented a seminar to foresters, land managers, and officers of that TIMO. Those seminars informed participants of the Federal status and threats to the Louisiana pine snake, conservation measures that could be practiced by those stakeholders, and potential ramifications of listing of that species.

The TPWD, LDWF, and the USFWS have been providing comments on pipeline development proposals within the Louisiana pine snake range requesting the installation of erosion control alternatives that do not utilize polypropylene ECBs. The TPWD Habitat Assessment Program currently recommends adherence to the Best Management Practices (BMPs) described by Rudolph (2011b, p. 2) in addition to other terrestrial vertebrate BMPs specifically addressing construction activities such as infrastructure and energy exploration and transmission projects.

Concentrating effort by using the LRSF Model to guide priorities, LDWF has been actively approaching landowners in the Louisiana pine snakes range in Louisiana to recruit them into the Natural Areas Registry Program (Gregory 2013a in litt.). By consenting to voluntarily register their properties into the Registry, landowners agree to: protect the area and its unique natural elements to the best of their abilities; notify the program representative of any threats to the area or the plants and animals within; and notify the program representative of an intent to sell or transfer ownership of the area. Each year LDWF will contact the owner to determine whether conditions have changed or new threats have developed. Participants can receive, free of charge, an annual ecological check-up on the health of the plants, animals, or habitat of special concern, preparation of a management plan, if needed, to assure the continued health of the natural area and consultation on how to protect the area should a transfer of ownership or other change become necessary. Furthermore, LDWF has made longleaf pine restoration a priority and is targeting suitable tracts of 5,000 acres or more for acquisition.

Lastly, Kwiatkowski *et al.* (2010) developed DNA Microsatellite primers to allow genetic analysis within

and between Louisiana pine snake populations. Preliminary results indicate low levels of heterozygosity and 31.3 percent of loci lacked Hardy-Weinberg equilibrium suggesting that populations are small and isolated. In 2012, the USFWS provided funding to LDWF to further analyze all of the available Louisiana pine snake genetic material. That analysis is expected to strengthen the determination of heterozygosity levels in the wild and captive populations, determine levels of inbreeding in wild and captive populations and population structure across wild populations, genotype captive individuals to maximize outbreeding efforts, and allow assignment of individuals to specific populations. The results from that study are expected in 2014.

## **Summary of Threats :**

The Louisiana pine snake is listed as a candidate species, thereby indicating the USFWS 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 historical habitat losses, coupled with the disruption of natural fire regimes, which have reduced the Louisiana pine snake to six small, isolated, naturally occupied areas. All of these remnant individuals may be vulnerable to factors associated with low population sizes and demographic isolation such as reduced genetic heterozygosity. Habitat conditions on Federal lands are improving. However, the historical and ongoing loss or unavailability of preferable habitat (via fire suppression, conversion to short rotation, dense-canopy, off-site pine plantations, increases in the number and width of roads, and urbanization) on private lands in the matrix between these extant populations has eliminated dispersal among remnant populations and the natural re-colonization of vacant suitable habitat patches. Because it is extremely unlikely that corridors linking extant populations will be established, the loss of any extant population would be permanent without future reintroduction from captive-bred individuals. Louisiana pine snake populations on Federal lands have received increased management attention (via prescribed burning and thinning) in recent years primarily due to RCW management and the Louisiana pine snake CCA, and as a result the successional degradation of occupied and preferable habitat within these areas 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 in Bienville Parish, LA. Although two conservation areas are managed to benefit Louisiana pine snakes on this property, the majority of the estimated occupied habitat between the conservation areas, and the remainder of this populations entire estimated occupied habitat, is threatened by past conversion and ongoing land management activities (habitat conversion to short-rotation pine plantations) that are expected to decrease habitat quality.

Additional threats which 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 publics 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) 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, 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 :**

- Continue to present the option of CCAAs to willing landowners to protect significant portions of the Louisiana pine snakes range that occur on private property. Commitments from private landowners through conservation easements and/or CCAAs that habitat will be managed long-term for the benefit of this snake will be required to conserve this species.
- Develop a Conservation Strategy to outline the highest priority conservation efforts for the Louisiana pine snake.
- Continue or re-establish Louisiana pine snake trapping within the known OHMCPs and additional areas that the LRSF Model has shown to be preferable to snakes outside of the OHMCPs. Improved status assessment is dependent on continuing to collect recent occurrence and spatial distribution data for this species.
- Improve assessment of Louisiana pine snake population status and range by continuing to pursue access to survey additional private lands across the historical range of the species, facilitated by the LRSF Model.
- Continue pursuing potentially better methods of occurrence monitoring, such as pressure-activated or time-lapse camera traps, that could increase the potential observation of such a difficult species to trap.
- Begin field evaluation of and actual surveys with the two scent-detection dogs that are currently being trained under the guidance of the Memphis Zoo and Louisiana Department of Wildlife and Fisheries.
- Enhance existing and/or establish longleaf pine forests within occupied and preferable Louisiana pine snake habitat.
- Within occupied and preferable Louisiana pine snake habitat, reduce and or remove midstory component within pine forest stands to a level that allows maintenance by prescribed burning.
- Within occupied and preferable Louisiana pine snake habitat, implement a prescribed-burning program (typical 3 to 5-year intervals once the forest is in a maintenance condition) to reduce the midstory forest component and maintain the herbaceous layer.
- Within occupied and preferable Louisiana pine snake habitat, reduce timber stand density through selective thinning to allow sunlight to reach the ground thereby enhancing the herbaceous layer and pocket gopher habitat.
- Within occupied and preferable Louisiana pine snake habitat, manage timber primarily for ecological restoration or on longer rotations and for higher end products such as saw timber and poles.
- Within occupied and preferable Louisiana pine snake habitat, limit off-road vehicular use and consider/continue road closures.
- Provide conservation education to the general public, and to managers, hunters and other recreational users to avoid killing or otherwise impacting snakes in the wild.
- Educate collectors and other members of the public on the rarity of the Louisiana pine snake and the need to refrain from removing the species from the wild.
- Continue captive breeding and experimental reintroduction program to enhance populations within suitable habitat actively managed for Louisiana pine snake.
- Continue to progress on the assessment of captive-breeding stock and wild-caught specimen genetics to attempt to determine long-term viability of the species.
- Use the results of the genetics assessment and analysis to guide decision-making for management of captive stocks and the reintroduction program.
- Through addition to the Louisiana Wildlife Action Plan, acquire funding and encourage research on pocket gophers.

## **Priority Table**

Magnitude	Immediacy	Taxonomy	Priority
<b>High</b>	Imminent	Monotypic genus	1
		Species	2
		Subspecies/Population	3
	Non-imminent	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 six extant natural populations; all of these populations have been impacted by significant 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 (54 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 burning. That type of silviculture is well-suited to maintaining and/or enhancing Louisiana pine snake habitat. All extant populations are currently small, isolated, and fragmented by widespread historical loss and ongoing unavailability of potential habitat (via fire suppression, conversion to shortrotation pine plantations, increases in the number and width of roads, and urbanization) that has occurred on the private lands between remnant populations. The loss of potential habitat in the intervening areas has eliminated dispersal among remnant populations and natural re-colonization of vacant suitable habitat patches. All 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 the largest extant Louisiana pine snake population is threatened by activities (habitat conversion to short-rotation pine plantations) that are expected to decrease habitat quality.

The identified threats to all extant Louisiana pine snake populations leads us to conclude that the magnitude of the threats to this species remain high.

#### **Imminence :**

The historical loss in quantity and quality of open canopy longleaf pine habitat is the most significant factor impacting the current status of the Louisiana pine snake. The vast majority of that loss occurred by the mid-1930's (Bridges and Orzell 1989, p. 246; Frost 1993, p. 30) and virtually all virgin timber in the south was cut during intensive logging from 1870 to 1920 (Frost 1993, p. 38). Several localized threats continue to impact remnant Louisiana pine snake populations and their habitat (i.e.: inadequate prescribed burning in occupied habitat). As noted above, many current silvicultural practices on private lands maintain degraded habitat quantity and quality or reduced suitable habitat availability for the Louisiana pine snake. To the extent

that conversion to dense, short-rotation loblolly pine plantation degrades habitat quality, the Bienville population has historically experienced large-scale habitat degradation in the lands outside of the CMAs. While some remaining preferable habitat may exist on private lands that currently (or may in the near future) are undergoing degradation, the vast majority of that conversion has already occurred. The condition of occupied or potentially occupied preferable habitat within the Scrappin Valley population appears to be stable or improving due to active management although the largest contiguous parcel of that property has been sold by an industrial timber company and subsequently subdivided and sold to smaller private investors. The new owner of the area most important to Louisiana pine snakes (which also contains RCWs) is interested in continuing a suitable prescribed burning regime and has burned 320 ha (790 ac) of that property in 2013/early 2014. More significantly, management by signatories of the CCA is currently stabilizing, improving, or increasing the quantity and quality of habitat through longer rotations, prescribed burning on a 3-5 year cycle, and canopy thinning for Louisiana pine snakes on Federal lands.

All extant Louisiana pine snake populations are currently both small and isolated. Therefore, the Louisiana pine snake is vulnerable to loss of demographic viability and increased susceptibility to stochastic environmental factors (e.g., weather events, disease) across its range. Although these remnant populations are intrinsically vulnerable and thus threatened by those factors, the practices that created the habitat conditions that reduced population size and caused isolation and fragmentation had mostly occurred by the mid-1930s.

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?

Most of the longleaf pine habitat of the Louisiana pine snake has been destroyed for decades and much of the remaining habitat has already been degraded. Louisiana pine snake habitat loss is continuing at a slower rate than in the past, and is being stabilized, reduced, or recovered on Federal lands and a small amount of private lands. Voluntary, proactive 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 and updated 2013 CCA and a private landowner has successfully used a Private Stewardship Grant to directly address Louisiana pine snake conservation on a small portion of a private landholding. Private landowners are also demonstrating interest in the CCA through their presence and involvement at annual stakeholder meetings between 2003 and 2013. The USFWS intends to present the benefits of CCAs to any interested private landowners throughout the species' range. Two large private landowners are in active negotiations with the USFWS on terms of potential CCAs. Additionally LDWF is actively pursuing willing private landowners interested in enrolling their property in the Louisiana Natural Areas Registry and/or committing to conservation easements within the Louisiana pine snake's occupied range.

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

## **Description of Monitoring:**

In 2013, trapping surveys for the Louisiana pine snake occurred within limited sections of occupied habitat for all known extant Louisiana pine snake populations. Trapping effort within the OHMCP of the Kisatchie, LA population and on private land within the Bienville, LA population resumed in 2012. The USFS/SRS has built, installed, and will monitor five new traps in the vicinity of the 2008 Louisiana pine snake record in Nacogdoches County near Garrison, TX (Rudolph 2014 in litt.). Results of those surveys are discussed at annual Louisiana pine snake stakeholder meetings. 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 APTRs were deployed at the release sites (Rudolph and Reichling 2010, p.1). Those recorders generate very limited dispersal and survival data for some of those reintroduced snakes and the results are described above.

In early 2012, traps were installed or refurbished within the Scrappin Valley, TX, Sabine, TX (Fox Hunters Hill), and Angelina, TX populations and 2 new sites were planned to be trapped in Wood County, TX within 10 to 20 miles of historical localities. At the Angelina and Sabine, TX populations, some traps have been relocated and additional traps have been installed to increase the probability of capture (Rudolph 2012 in litt.). Twelve traps were installed in 2012, monitoring continued in 2013, and will continue in 2014, within the Kisatchie, LA population at sites that have suitable potential habitat as determined by the LRSF model combined with Bairds pocket gopher colony occurrence (Kohls 2012 pers. comm.). In 2014, the Bienville, LA, Fort Polk/Vernon, LA, Kisatchie, LA, and Peason Ridge, LA, OHMCPs are also planned to continue to be trapped.

**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.

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### **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:

A handwritten signature in black ink, appearing to be 'R.A. Young', written over a horizontal line.

07/29/2014

Date

Concur:



11/18/2014

Date

Did not concur:

\_\_\_\_\_

\_\_\_\_\_

Date

Director's Remarks: