Supplemental Information for the Florida (Peninsula)

Ribbon Snake Biological Status Review Report

The following pages contain peer reviews received from selected peer reviewers, comments received during the public comment period, and the draft report that was reviewed before the final report was completed

March 31, 2011

Table of Contents

Peer review #1 from Kenneth Wray

From: Ken Wray
To: Imperiled
Subject: Re: Deadline reminder for peer reviews of BSR reports
Date: Monday, January 31, 2011 7:41:43 PM
Attachments: BSR Florida Keys Mole Skink.docx
BSR Key Ringneck Snake
BSR Lower Keys Population of the Florida Brown Snake.docx
BSR Lower Keys Population of the Peninsula Ribbon Snake.docx
BSR Lower Keys Population of the Red Rat Snake.docx
BSR Rim Rock Crowned Snake.docx
BSR Short-tailed Snake.docx

Greetings Dr. Haubold-

Attached you will find seven BSR reviews for species/populations I was asked to review. Please let me know if there is anything else you need from me.

Best regards,

Ken Wray

Independent Review of the Biological Status Review for the Lower Keys Populations of the Peninsula Ribbon Snake (*Thamnophis sauritus sackenii*)

Kenneth P. Wray

1. Completeness and accuracy of the biological information and data analyses:

This review is thorough. Comparisons with other, closely related, populations seem reasonable and justified. Data analyses are appropriate.

2. Reasonableness and justifiability of the assumptions, interpretations of the data, and conclusions:

Any assumptions made are conservative and reasonably grounded in the available data for this, and other, populations. Data interpretation is fair and sound.

However, I disagree with the panel's choice to not recognize this population as threatened based on this population apparently representing the southern end of a north-south cline. There is reasonable data suggesting that this population varies in scalation. Furthermore, based on life history traits, it is reasonable to assume that the lower keys population is isolated geographically from peninsular and upper keys populations (particularly since these records are from the northern end of the upper keys), similar to patterns seen in many other Keys populations (e.g. *Storeria victa*). Given the IUCN Red List criterion that have been met for this population and the fact scalation differences exist, as well as the nearest populations being 50+ miles to the NE across inhospitable habitat, this seems to be a case where the precautionary principle should be invoked, at least until further data can be gathered. A status of threatened seems warranted for this taxon based on this review.

Peer review #2 from Pierson Hill

From: Pierson Hill
To: Imperiled
Subject: Re: Deadline reminder for peer reviews of BSR reports
Date: Wednesday, February 16, 2011 2:38:13 AM
Attachments: BSR_Diapunacr_EPH.docx
BSR_Stovic(Keys)_EPH.docx
BSR_Thasau(Keys)_EPH.docx

Hello,

Please find attached my reviews of the Key Ringneck Snake, the Florida Ribbon Snake, and the Florida Brown Snake.

Sincerely,

Pierson Hill

Independent Review of the BSR of the Lower Keys populations of the Florida Brown Snake (*Storeria dekayi victa*)

Pierson Hill
Florida State University, Tallahassee, FL 32306
phill@bio.fsu.edu

1. *Completeness and accuracy of the biological information and data analyses*

   To my knowledge, the BSR incorporates all pertinent information concerning the Lower Keys population of Florida brown snakes. Analyses of potential occurrence, population size, and quantification of habitat are sufficient and accurate.

2. *Reasonableness and justifiability of assumptions, interpretations of the data, and conclusions*

   Evidence for the distinctiveness of the Lower Keys population of brown snakes is currently confined to minor color and differences in scalation between it and the geographically proximate populations in the Upper Keys and mainland. The similarity of this population to those in the Florida panhandle raises doubts as to their origins and affinity, and therefore their significance as a genetically discrete entity. Unfortunately, there is no genetic data available at present to allow us to evaluate the issue. However, because several other Lower Keys reptiles exhibit a similar pattern of relatedness (e.g. *Nerodia clarkii*), Paulson's (1968) hypothesis is not unreasonable and the most conservative course of action is to treat the Lower Keys populations as distinct until population genetic data is analyzed.

   Assuming that the Lower Keys populations are significant and discrete, the lack of records in recent decades is alarming. Unfortunately, there isn't enough data to detect population trends through time, so the extent and potential causes of any declines are impossible to know. Therefore, I agree with the reviewers' decision to rely on range, occurrence, and habitat data to inform the listing decision and I agree with the data they present in their justification of listing the Lower Keys populations of *Storeria dekayi* as Threatened.

Peer review #3 from Dr. Richard Seigel

From: rseigel
To: Imperiled
Subject: Re: Deadline reminder for peer reviews of BSR reports
Date: Thursday, February 10, 2011 4:06:54 PM
Attachments: Ribbon Snake Final Draft BSR 12-21-10.docx

Caly:

My review is attached, done using Word's Track Changes. I also provided a summary of my comments under " **SUMMARY OF THE INDEPENDENT REVIEW"**

Please let me know if you have any questions,

Richard A. Seigel
Chair
Dept. of Biological Sciences
Towson University
8000 York Rd.
Towson, MD 21252

Biological Status Review
for the
Peninsula Ribbon Snake (Lower Keys Population)
(*Thamnophis sauritus sackenii*)

EXECUTIVE SUMMARY

The Florida Fish and Wildlife Conservation Commission (FWC) directed staff to evaluate all species listed as Threatened or Species of Special Concern as of September 1, 2010. Public information on the status of the Lower Keys population of the peninsula ribbon snake was sought from September 17 through November 1, 2010. The 3-member biological review group (BRG) met on November 19, 2010. Group members were Kevin Enge (FWC lead), Steve Johnson (University of Florida), and Paul Moler (independent consultant) (Appendix 1). In accordance with rule 68A-27.0012 F.A.C, the BRG was charged with evaluating the biological status of the Lower Keys population of the peninsula ribbon snake using criteria included in definitions in 68A-1.004 and following protocols in the *Guidelines for Application of the IUCN Red List Criteria at Regional Levels (Version 3.0)* and *Guidelines for Using the IUCN Red List Categories and Criteria (Version 8.1)*. Please visit http://myfwc.com/docs/WildlifeHabitats/Imperiled_EndangeredThreatened_FinalRules.pdf to view the listing process rule and the criteria found in the definitions.

The BRG concluded from the biological assessment that the Lower Keys population of the peninsula ribbon snake met 2 listing criteria. Although the Keys population of peninsula ribbon snakes differs somewhat in scale pattern and color from mainland populations, these differences are seen as the southern end of character states that vary geographically (clinally) from north to south. They are not considered strong evidence of an isolated population because they are reflective of the normal north-south geographic variation of the species in Florida. Therefore, FWC staff recommends that the Lower Keys population of the peninsula ribbon snake be removed from Florida's list of Threatened species.

This work was supported by a Conserve Wildlife Tag grant from the Wildlife Foundation of Florida.

BIOLOGICAL INFORMATION

Taxonomic Classification – The peninsula ribbon snake (*Thamnophis sauritus sackenii* Kennicott,1859) occurs in peninsular Florida and southeastern Georgia. It typically has 8 supralabials, a tan to brown dorsum, and a buff to tan-colored middorsal stripe that may be indistinct or completely absent. Peninsula ribbon snake characteristics vary gradually (clinal variation) from north to south in Florida, and lower Keys populations represent the southern end of those clines. Because the geographic variation is continuous, it does not indicate that the Keys population is taxonomically distinct. The middorsal stripe in the lower Keys population is yellow, orange, or tan bordered on each side by a narrow black stripe (Weaver et al. 1992). The number of supralabial scales is occasionally 7, instead of 8 (Christman 1980), although 10 specimens examined by Lazell (1989) had 8 supralabials.

Comment [RS1]: I am guessing there are no molecular data available? This should be stated in the text

Life History and Habitat Requirements – Information on the species has been summarized by Lazell (1989), Weaver et al. (1992), Rossman et al. (1996), and Ernst and Ernst (2003). The peninsula ribbon snake inhabits the margins of freshwater habitats, where it forages and shelters in grass and shrub vegetation, but in the Lower Keys, it also inhabits mangrove systems and *Spartina* marshes (Weaver et al. 1992). It is not entirely restricted to fresh water but can exist in brackish zones, apparently tolerating some levels of saltwater. Lazell (1989), however, stated that this species is "tightly tied to open fresh water habitats: the rare, tiny marshes left in the Lower Keys." Florida Natural Areas Inventory (FNAI) records indicate that snakes have been found around scattered small freshwater marshes, sinkholes, and large cattail (*Typha* sp.) marshes in both pine rocklands and rockland hammocks, and 1 snake was found adjacent to a rockland hammock near tidal swamp and coastal rock barren. Ribbon snakes can bear 3–26 live offspring, but the litter size is typically 10–12 (Ernst and Ernst 2003). Two females from the Lower Keys had 5 and 8 young (Lazell 1989). Southern populations may produce 2 litters annually, but this has not been confirmed (Rossman et al. 1996). Snakes in Everglades National Park were gravid in June and August–October (Dalrymple et al. 1991). Peninsula ribbon snakes are diurnal and nocturnal and have been found crossing roads at night in the Keys (Lazell 1989, Weaver et al. 1992). Ribbon snakes are good climbers and swimmers. They consume frogs, including the introduced Cuban treefrog (*Osteopilus septentrionalis*) and fish, but lizards appear to be the primary prey in the Lower Keys (Weaver et al. 1992, Ernst and Ernst 2003). Specific predators are unknown, but raccoons (*Procyon lotor*), crabs, raptors, and feral and domestic cats and dogs, are known to kill and eat small snakes and may be a threat.

Population Status and Trend – Studies of population sizes and changes over time have not been conducted on this species in Florida or Georgia. The Lower Keys population of the peninsula ribbon snake is assumed to have declined due to development of suitable upland habitat and loss of small freshwater marshes. According to Paulson (1968), ribbon snakes "are apparently not uncommon on those keys with permanent fresh water." Although no surveys have been undertaken, this snake probably still occurs on all 8 keys on which it has been found. There are records since 2000 from Big Pine, Middle Torch, Saddlebunch, Sugarloaf, and Upper Sugarloaf keys. There are records from the 1990s for Little Torch and No Name Keys and from 1985 from Cudjoe Key.

Comment [RS2]: Information on changes in # of snakes encountered in road surveys are available in Seigel et al (2002 Florida Sci Vol 65)

Geographic Range and Distribution – The peninsula ribbon snake has been documented from extreme southern South Carolina, through the Georgia Coastal Plain and south through the Florida peninsula to the Lower Keys. In the Lower Keys, ribbon snakes have been found on Big Pine, Cudjoe, Little Torch, Middle Torch, No Name, Saddlebunch, Sugarloaf, and Upper Sugarloaf keys (Lazell 1989, Weaver et al. 1992, museum and Florida Natural Areas Inventory records) (Fig. 1). The only other records of the species in the Keys are from Key Largo (Fig. 1).

Quantitative Analyses – We are not aware of a population viability analysis conducted for the Lower Keys population of the peninsula ribbon snake or for this species overall. Loss of habitat due to sea level rise over the next 100 years is likely to reduce its preferred habitat in the Keys and cause population declines. A baseline population estimate would greatly enhance the accuracy of future estimates.

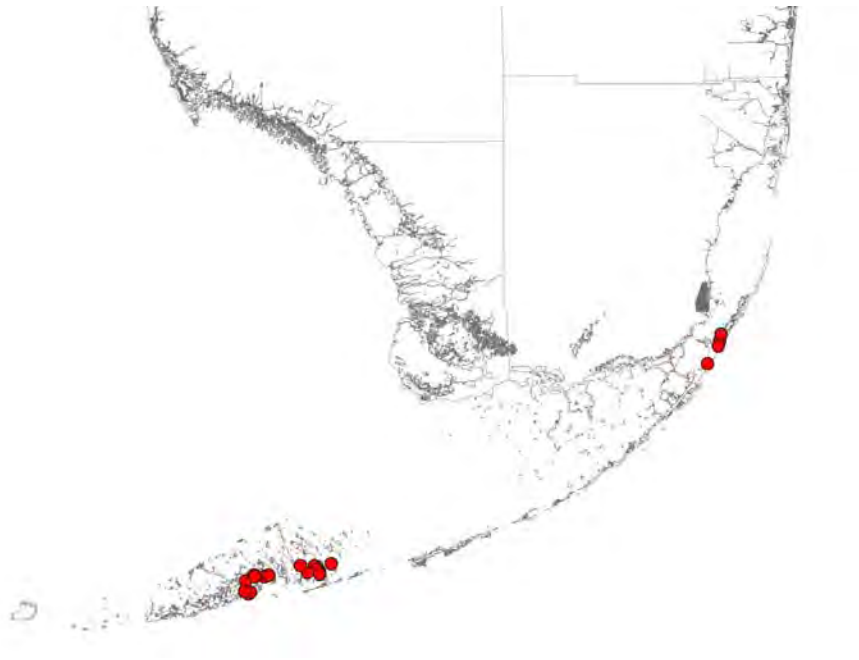

Fig. 1. Locality records from museums and FNAI for peninsula ribbon snakes in the Florida Keys (only the westernmost records represent the Lower Keys population).

BIOLOGICAL STATUS ASSESSMENT

Threats – Clearing of hammocks and areas around wetlands has probably eliminated peninsula ribbon snakes from some areas, particularly if snakes are restricted to habitats in proximity to sources of fresh water with surrounding grass and shrub vegetation. However, populations may persist in areas where the landscape has been cleared and left vacant to undergo ecological succession, especially where freshwater sources remain. Road mortality removes adults from the population, as indicated by literature, museum, and FNAI records (Paulson 1968, *see* Lazell 1989, Ernst and Ernst 2003). Big Pine Key, with its dense network of roads, may be a prime area for road mortality. The nonnative cane toad (*Rhinella marina*) and Cuban treefrog (*Osteopilus septentrionalis*) are known to eat small snakes (Meshaka et al. 2004, Krysko and Halvorsen 2010) and may be a threat to small ribbon snakes. Hurricanes strike South Florida about every 3 years (Gentry 1974), and associated seawater surges and short-term flooding of upland habitats in the Keys may kill some snakes and their prey. After Hurricane Georges, a Category 2 hurricane, 4 of 15 monitored freshwater holes in the Lower Keys had salinities >15 ppt due to the storm surge, and these higher salinities sometimes remained months later (Lopez et al. 2003). A stronger storm (>Category 3) would have a greater impact due to stronger winds and greater storm surge (>3.5 m); a storm surge of 4 m (13 feet) would result in the complete submersion of Big Pine Key and No Name Key, which provide ca, 51% of the 276 freshwater

Comment [RS3]: See also Seigel et al 2002

sources for the Key Deer (*Odocoileus virginanus clavium*) and presumably the peninsula ribbon snake (Lopez et al. 2003). In 2005, Hurricane Wilma (Category 3) passed just north of the Florida Keys, causing 2 storm surges. The second storm surge caused maximum storm tides 1.5–1.8 m (5–6 feet) above mean sea level in Key West (60% of the city was flooded) and 1.5–2.4 m (5–8 feet) between Boca Chica and Big Pine keys (Kasper n.d.). The Florida Keys have been hit with more intense hurricanes, such as the Labor Day Hurricane of 1935 (Category 5) and Hurricane Donna (Category 4) in 1960. Ribbon snakes and their prey, especially the anurans, would be significantly impacted by storm surges that increased the salinity of freshwater wetlands. A sea level rise due to climate change could significantly impact this taxon. In the best-case scenario, a sea level rise of 18 cm (7 inches) by Year 2100 would inundate 34% of Big Pine Key, resulting in the loss of 11% of the island's upland habitat (http://frrp.org/SLR%20documents/FINAL%20-%20Aug%2021%20-WITH%20COVER.pdf) and inundating coastal habitats used by the species. In the worst-case scenario, a sea level rise of 140 cm (4.6 feet) by Year 2100 would inundate 96% of Big Pine Key.

Lower Keys Population Assessment – Findings from the BRG are included in Biological Status Review Information tables. They found the Lower Keys population of the peninsula ribbon snake met listing sub-criteria B1, B2, and D2.

LISTING RECOMMENDATION

The Lower Keys population of the ribbon snake is not taxonomically distinct. Although the Keys population of peninsula ribbon snakes differs somewhat in scalation (number and location of scales) from mainland populations, these differences are seen as the southern end of character states that vary clinally (geographically) from north to south. They are not considered strong evidence of an isolated population because they are reflective of the normal north-south geographic variation of the species in Florida. Therefore, FWC staff recommends that the Lower Keys population of the peninsula ribbon snake be removed from Florida's list of Threatened species.

SUMMARY OF THE INDEPENDENT REVIEW

Comments by Rich Seigel

I have no serious reservations about this BSR. With one exception, it does a good job in reviewing the current literature, and the overall conclusion regarding taxonomy appears to be reasonable. However, the authors should state whether they have determine whether or not any molecular data are available on this species, as such data could very well result in the Keys populations actually being distinctive.

Copy of the Florida (Peninsula) ribbon snake BSR draft report that was sent out for peer review

Biological Status Review
for the
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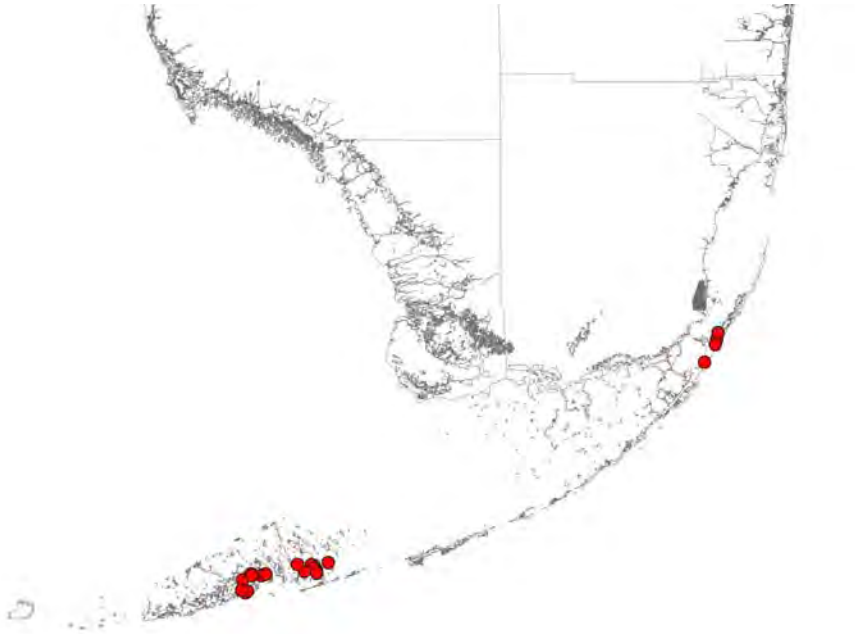

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SUMMARY OF THE INDEPENDENT REVIEW

To be added after the peer review.

LITERATURE CITED

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There's an extra line here

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Biological Status Review Information
Findings

Species/taxon: Peninsula Ribbon Snake, Lower Keys population
Date: 11/19/10
Assessors: Enge, Johnson, Moler

Generation length: 4 years

Criterion/Listing Measure	Data/Information	Data Type*	Criterion Met?	References
*Data Types - observed (O), estimated (E), inferred (I), suspected (S), or projected (P). Criterion met - yes (Y) or no (N).				
(A) Population Size Reduction, ANY of				
(a)1. An observed, estimated, inferred or suspected population size reduction of at least 50% over the last 10 years or 3 generations, whichever is longer, where the causes of the reduction are clearly reversible and understood and ceased[1]	Causes of reduction have not ceased (c)	S	N	
(a)2. An observed, estimated, inferred or suspected population size reduction of at least 30% over the last 10 years or 3 generations, whichever is longer, where the reduction or its causes may not have ceased or may not be understood or may not be reversible[1]	<30% population size reduction because of 8.1% decline in human population in Keys since 2000 and limits on development; population size in peninsula Florida will continue to decrease with human population growth and urban development.	S	N	Monroe County (1999), U.S. Census Bureau
(a)3. A population size reduction of at least 30% projected or suspected to be met within the next 10 years or 3 generations, whichever is longer (up to a maximum of 100 years) [1]	<30% population size reduction because of projected 2.2% human population increase in Keys in next 12 years and limits on development; likewise in peninsula Florida with human population size increase; population size reduction >30% in expansion of urban areas.	S	N	Monroe County (1999), Zwick and Carr (2006)
(a)4. An observed, estimated, inferred, projected or suspected population size reduction of at least 30% over any 10 year or 3 generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased or may not be understood or may not be reversible.[1]	<30% population size reduction (see A2 and A3); statewide population size decline likely in 4 generations due to increasing urban human population growth and loss of habitat.	S	N	Monroe County (1999), Zwick and Carr (2006)
[1] based on (and specifying) any of the following: (a) direct observation; (b) an index of abundance appropriate to the taxon; (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat; (d) actual or potential levels of exploitation; (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.				
(B) Geographic Range, EITHER				
(b)1. Extent of occurrence < 20,000 km^2 (7,722 mi^2) OR	137.3 km^2 in Keys but larger and unknown in peninsula Florida	E	Y	Monroe County (1999)

(b)2. Area of occupancy < 2,000 km^2 (772 mi^2)	61.5 km^2 in Lower Keys, but much larger (>>20,000 km^2) in Florida peninsula	E	Y	GIS analysis of potential habitat by B. Stys (FWC)
AND at least 2 of the following:				
a. Severely fragmented or exist in ≤ 10 locations	On 8 islands but thought to be in 1 or 2 locations because storm surges could kill some snake and seriously impact anuran prey base and population sizes,, and in the Florida peninsula >>10 populations but severely fragmented.	S	Y	
b. Continuing decline, observed, inferred or projected in any of the following: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent, and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals	Continuing decline in iii for Lower Keys populations but also for many mainland peninsula populations.	P	Y	Monroe County (1999)
c. Extreme fluctuations in any of the following: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals	Choices 1014	S	N	
(C) Population Size and Trend				
Population size estimate to number fewer than 10,000 mature individuals.	There are not enough data for population estimates in the Florida Keys or anywhere in Florida	S	N	Carpenter (1952), Clark (1974), Bell et al. (2007), GIS analysis of potential habitat by B. Stys (FWC)
(c)1. An estimated continuing decline of at least 10% in 10 years or 3 generations, whichever is longer (up to a maximum of 100 years in the future) OR	2.2% percent human population increase predicted unlikely to cause 10% decline in snakes from habitat loss.	S	N	
(c)2. A continuing decline, observed, projected, or inferred in numbers of mature individuals AND at least one of the following:	Some rangewide decline likely due to development and habitat loss	P	Y	
a. Population structure in the form of EITHER	Uncertain	S	N	
(i) No subpopulation estimated to contain more than 1000 mature individuals; OR				
(ii) All mature individuals are in one subpopulation		O	N	
b. Extreme fluctuations in number of mature individuals		S	N	
(D) Population Very Small or Restricted, EITHER				
(d)1. Population estimated to number fewer than 1,000 mature individuals; OR	>1,000 mature individuals	S	N	
(d)2. Population with a very restricted area of occupancy (typically less than 20 km^2 [8 mi^2]) or number of locations (typically 5 or fewer) such that it is prone to the effects of human activities or stochastic events within a short time period in an uncertain future	On eight islands but thought to be in 1 or 2 locations because storm surges could kill some snakes and impact the anuran prey base; populations on mainland not so restricted.	E	Y for Lower Keys	

(E) Quantitative Analyses				
e1. Showing the probability of extinction in the wild is at least 10% within 100 years	No PVA		N	

Initial Finding (Meets at least one of the criteria OR Does not meet any of the criteria)	Reason (which criteria are met)
Threatened	B1+B2ab(iii); D2
Is species/taxon endemic to Florida? (Y/N)	N
If Yes, your initial finding is your final finding. Copy the initial finding and reason to the final finding space below. If No, complete the regional assessment sheet and copy the final finding from that sheet to the space below.	
Final Finding (Meets at least one of the criteria OR Does not meet any of the criteria)	Reason (which criteria are met)
Threatened	B1+B2ab(iii); D2

Additional notes – Generation length is defined as the average age of parents of the current cohort, which is greater than the age at first breeding and less than the age of the oldest breeding individual. No demographic data exist. In Louisiana, *Thamnophis sauritus* becomes sexually mature at 2 years of age (Tinkle 1957), and a specimen lived >7 years in captivity (Ernst and Ernst 2003). We infer a generation length of 4 years.

Sub-criterion A2. – Actual estimates of ribbon snake populations and trends do not exist, but we suspect that loss and degradation of habitat probably have resulted in some decline in populations within the past 12 years. Urbanization resulted in extensive destruction of rockland habitats in the past, but vigorous litigation has slowed the previous uncontrolled rate of growth in the Keys (Morgenstern 1997). According to the U.S. Census Bureau, Monroe County's population decreased by 8.1% from 2000 through 2009. Freshwater wetlands are important both to Key deer and ribbon snakes, and freshwater lenses occur on Key West and on Big Pine Key, Cudjoe, No Name, Ramrod and Sugarloaf keys (Monroe County 1999). There has not been much loss of freshwater wetlands from development because of their importance to the Federally Endangered Key deer, and potable water in the Keys is provided by the Florida City Wellfield in Miami-Dade County. Introduced species have probably been more beneficial than detrimental to ribbon snake populations, providing additional frogs and lizards to eat.

Sub-criterion A3. – Three generations from 2010 would be 2022. By the Year 2020, Monroe County's population is projected to increase by 2.2% (Zwick and Carr 2006). However, Monroe County's population has been decreasing, and according to the U.S. Census Bureau, the population in 2009 was only 73,165, not the 82,414 that was projected (http://quickfacts.census.gov/qfd/states/12/12087.html). Of the potential habitat identified using GIS analysis, 62.8% is protected in conservation lands, preserves, or easements (B. Stys, FWC, pers. commun. 2010), and there are restrictions on clearing rockland habitat on private lands.

Sub-criterion B1. – The land area of the Lower Keys, not including offshore islands, is ca. 137.3 km^2 (53.0 mi^2) (Monroe County 1999). The total land area of the Florida Keys, which consists of ca. 1,700 islands, is ca. 356 km^2 (137.3 mi^2) (http://en.wikipedia.org/wiki/Florida_Keys).

Sub-criterion B2. – A GIS analysis of potential habitat for the Lower Keys population identified 61.5 km^2 (23.8 mi^2) of potential habitat (B. Stys, pers. commun.), which we will assume is equivalent to the area of occupancy. The 7 islands included in the GIS analysis were Big Pine, Big Torch, Cudjoe, Middle Torch, Little Torch, No Name, and Sugarloaf keys. The presence of the species on the Saddlebunch Keys, which now represents the farthest west record, was unknown at the time of the analysis. The predominant FWC 2003 land-cover classes that comprised most of the potential habitat were mangrove swamp (17.5 km^2; 6.8 mi^2), scrub mangrove (12.4 km^2; 4.8 mi^2), tropical hardwood hammock (11.4 km^2; 4.4 mi^2), salt marsh (11.1 km^2; 4.3 mi^2), and pinelands (8.8 km^2; 3.4 mi^2). Based upon future development and clearing of habitat, we project a continuing decline in area of occupancy, extent of habitat, and number of mature individuals. The taxon is known from 8 islands in the Lower Keys, but we are uncertain whether the population can be considered severely fragmented. Ribbon snakes swim well and occupy some coastal habitats. Many of these keys are separated by narrow channels that are sometimes <1 km wide, and "subpopulations" on these islands may experience demographic or genetic exchange (i.e., >1 migrant individual per year). However, the Lower Keys inhabited by ribbon snakes could all be considered 1 or 2 locations. A "location" is a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon present. The 8 inhabited keys extend across an area of only ca. 30 km (19 miles), and form 2 clusters (Fig. 1). A storm surge of salt water from a severe hurricane (Category 3 or higher) could completely overwash these 8 islands (*see* Threats section), killing individuals, increasing the salinity of freshwater wetlands, and affecting prey populations, particularly anurans and fish. There is no evidence that the ribbon snake experiences extreme fluctuations.

Criterion C. – No data on population densities exist for the ribbon snake in the Lower Keys or elsewhere in Florida. At a site in Michigan, common ribbon snakes (*Thamnophis s. sauritus*) had an estimated density of 23 snakes/ha (9.3 snakes/acre) (Carpenter 1952). At a site in Nova Scotia, common ribbon snakes had an estimated density of almost 6 snakes/ha (Bell et al. 2007). At a site in Texas, western ribbon snakes had estimated densities ranging from 16 to 61 snakes/ha over a 3-year period (Clark 1974). None of these studies apparently differentiated between adult and juvenile snakes. Ribbon snakes are abundant in many wetland and pine flatwoods habitats in Florida (Enge 1997). During a road survey in Long Pine Key, Everglades National Park, 211 ribbon snakes were found (11.8% of all snake captures) (Dalrymple et al. 1991). Almost 2,600 snakes were collected during 1 year in Florida for the pet trade, primarily from south of Lake Okeechobee (Enge 2005). If we assume a density of 10 snakes/ha (4 snakes/acre) and that all potential habitat (6,155 ha; 15,209 acres) is occupied, then there is an estimated population of ca. 60,000 ribbon snakes in the Lower Keys. Of course, all potential habitat is probably not occupied, but the amount of potential habitat is greater if one includes the Saddlebunch Keys. This population estimate is probably inaccurate, but we suspect that the population exceeds 10,000 mature individuals.

Sub-criterion D2. – The Lower Keys populations of the peninsula ribbon snake could be considered to occur in only 1 or 2 locations (clusters of nearby islands) that are prone to the effects of a stochastic event (e.g., hurricane) within a short time period in the future.

Appendix 1. Biological Review Group Members Biographies

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

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

Paul E. Moler received his M.S. in Zoology from the University of Florida in 1970 and his B.A. in Biology from Emory University in 1967. He retired in 2006 after working for 29 years as a herpetologist with FWC, including serving as administrator of the Reptile and Amphibian Subsection of the Wildlife Research Section. He has conducted research on the systematics, ecology, reproduction, genetics, and conservation biology of a variety of herpetofaunal species in Florida, with primary emphasis on the biology and management of endangered and threatened species. He served as Chair for the Florida Committee on Rare and Endangered Plants and Animals in 1992–94, Chair of the Committee on Amphibians and Reptiles since 1986, and editor of the 1992 volume on amphibians and reptiles. Paul has >90 publications on amphibians and reptiles.

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

No additional public information was received during the public solicitation period.

APPENDIX 3. Information and comments received from independent reviewers.

To be added after peer review.