Supplemental Information for the Rim Rock Crowned 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

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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 Florida Rim Rock Crowned Snake (*Tantilla oolitica*)

Kenneth P. Wray

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

This review is thorough, particularly when considering the lack of natural history information for this species. Comparisons with other species 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 closely related, species. Data interpretation is fair and sound. Conclusions are valid given the results of this review. A status of threatened seems warranted for this taxon based on this review.

Peer review #2 from Louis Porras

From: louis porras
To: Imperiled
Subject: comments on Tantilla oolitica report
Date: Monday, January 17, 2011 2:55:27 PM
Attachments: Tantilla oolitica.docx

Dear Dr. Haubold,

Attached please find my comments on the BGR report for the rim rock crowned snake (*Tantilla oolitica*). Please do not hesitate to contact me if you have any questions.

Yours sincerely,

Louis W. Porras
Eagle Mountain Publishing, LC
7705 Wyatt Earp Avenue
Eagle Mountain, UT 84005-4382

15 January 2011

Elsa M. Haubold, Ph.D.
Section Leader, Species Conservation Planning
Florida Fish & Wildlife Conservation Commission
620 South Meridian Street
Tallahassee, Florida 32399

Dear Dr. Haubold:

Some time ago I was contacted by Kevin Enge and asked to review a report on the biological status of the rim rock crowned snake (*Tantilla oolitica*). Initially, I hesitated in giving Kevin an answer, since all of my experience with this species was prior to 1982 (when I moved away from Florida), but once Kevin made me aware of the difficulty in obtaining qualified reviewers I agreed to look over the materials and submit my comments.

The BRG report was much more enlightening than I had anticipated, since I was unaware of the copious amount of distributional information on *T. oolitica* that had been accumulating over the past three decades. Still, because of the lack of natural history information available on this species, it was obvious that the authors were faced with the daunting task of evaluating the status of this snake and had no option but to speculate on several aspects of its biology. In spite of these restrictions, I found their report extremely informative and thorough and fully agree with their conclusions that *T. oolitica* should be listed as a Threatened species.

To provide a broader perspective on the suspected population density of this enigmatic species, I am including information on my recollections/experiences with *T. oolitica*. My hope is that this information might be useful in future research to more fully understand the biology of this snake.

I moved to Miami in 1955, and by the age of 12 (in 1960) had become an avid herpetofaunal enthusiast. I took every opportunity to search for amphibians and reptiles in empty lots throughout the city and along several of the major canals, and encountered a vast array of native and introduced herpetofauna. Among the smaller snake species, I turned up relatively large numbers of *Diadophis punctatus* and *Storeria dekayi*. About that time, I also became a regular attendee at meetings of the South Florida Herpetological Society, where I met several herpetological professionals, some full-time snake collectors, and numerous other enthusiasts. During my high-school years, I worked part-time for Charles P. Chase Co., one of the leading animal dealerships in the country. Mr. Chase had the largest herpetofaunal selection in the area, and routinely purchased amphibians and reptiles from a plethora of collectors. Consequently, at a rather young age, I was in contact with a substantial portion of the local herpetological community and was aware of the numbers and types of herpetofauna being collected throughout the area.

The types and quantities of amphibians and reptiles brought to animal dealers in the 1960s was nothing short of spectacular, and it wasn't unusual for dealers such as Bill Chase, The Pet Farm, and a handful of other others to purchase 1,000 or more snakes in a given week. Over a dozen "hunters" collected amphibians and reptiles on a full-time basis, but at least three times that

many people were part-time collectors. This situation reached a peak in the 1960s, as with the introduction of new legislation in the early 70s the number of professional collectors began to dwindle.

The significance of this information is that, until the late 1970s, I had never been aware of anyone who had collected a rim rock crowned snake, although I was given second hand information on two or three individuals that had been found in the city in the 1950s. In 1978, a *T. oolitica* was found in northern Key Largo by a local resident, and then another turned up on Grassy Key. This find prompted Larry David Wilson and I to obtain permits and we fortuitously found a second individual on Grassy Key, which we reported on. The following year I flipped a board next to a wooded area in North Key Largo and found another individual, and a short time later a collector in Miami informed me that he found and released a *T. oolitica* on the periphery of a remnant patch of pine woods along Krome Avenue—a highly unusual location.

This collective information, dating back five decades, suggests that *T. oolitica* was not a widespread species on the south Florida mainland, and that the distribution of this snake was primarily restricted to small pockets along the coastal ridge. While a surprising number of individuals have been encountered on the mainland in recent years, most of them apparently came from specific areas that likely were not visited by collectors in years past. If one considers the sparse number of museum specimens available from the mainland, the time and places when they were collected, and the amount of habitat that has been destroyed or substantially altered over time, *T. oolitica* can only be regarded as an extremely secretive or extremely uncommon snake…and perhaps both.

Compared to other small fossorial/semi-fossorial snakes found in south Florida, *T. oolitica* does not appear to adapt well to disturbed areas. When encountered in these areas, it generally has been within close proximity of natural or quasi-natural habitats. Of importance here is that if one considers the amount of natural cover in south Florida that has succumbed to development, the manipulation of the hydrologic cycle, taken over by introduced vegetation, exposed to biocides or pesticides, in addition to the numerous other pressures exerted on these habitats by humans, the “actual” remaining habitat for this species would appear to be very small. Future studies, therefore, should refocus on evaluating the amount of potential habitat for this species, in addition to a reevaluation of their population density. Additionally, mainland populations of *T. oolitica* are extremely fragmented, and certain areas in the BRG report considered as potential habitat might actually only be marginally used by this species and thus contain only a minimal number of animals. For example, I lived in the vicinity of the Miami Zoo for about a decade, and although I came across some species that are considered uncommon for the area (e.g., *Gopherus polyphemus*, *Micrurus fulvius*), I never found a *Tantilla*. The information provided by Dustin Smith and appended to the BGR report would seem to bear this out.

The lack of available natural history information for *T. oolitica* made it difficult for the authors to evaluate certain criteria. Thus, to ascertain the home range of *T. oolitica* comparisons were made with another species (*T. relicta neilli*). Although these species are classified in the same genus, I caution the use of such methodology as these are truly “different species” with a potential for having very different life histories. Similarly, I found that basing the age at maturity, clutch size, and total age of *T. oolitica* on information reported for *T. coronata*, a close

relative, was somewhat of a stretch. This lack of information clearly illustrates the need for conducting long-term natural history studies on *T. oolitica*.

Geographical/morphological differences in cephalic coloration, the presence/absence or shape of a nuchal band, and differences in the relative tail-length and the number of subcaudals in *T. oolitica* have been reported in the literature; additional information also appears in photographs on certain academic websites. To date, however, no molecular studies have been conducted on this taxon, and the possibility exists for greater differentiation in what today is regarded as *T. oolitica*. Confirmation of such differentiation could only lead to an even greater level of conservation concern.

I appreciate the opportunity to comment on this report.

Respectfully yours,

Louis W. Porras
Eagle Mountain Publishing, LC
7705 Wyatt Earp Avenue
Eagle Mountain, Utah 84005-4382
Telephone: (801) 789-4149

Peer review #3 from Kirsten Hines

From: Kirsten Hines
To: Imperiled
Subject: Tantilla oolitica review
Date: Thursday, February 03, 2011 9:34:16 AM
Attachments: Hines review_T. oolitica.doc

I have attached my comments on the rim rock crowned snake (Tantilla oolitica) biological status review. Please let me know if you have any questions or comments.

Thanks,
Kirsten
--
Kirsten Hines
260 Crandon Blvd, Ste 32-190
Key Biscayne, FL 33149, USA

Biological Status Review - *Tantilla oolitica*
Reviewer Comments - Kirsten N. Hines
February 3, 2011

I agree with the committee's recommendation to list the rim rock crowned snake (*Tantilla oolitica*) as threatened based on geographic range criteria under Florida's new endangered and threatened species rules. The document would benefit from some restructuring to increase clarity and data usage should be revisited as the available data is stretched beyond its limits in some cases.

The document itself would be more clear if the initial background information, particularly the "biological status assessment" section, were more consistent with the additional notes provided following the table of information findings (starting on page 12). It seems that the information most pertinent to the decision for proposing the threatened status is hidden in these notes. While there is relevant and useful information in the first section, it is not sufficient for the reader to understand the reasoning behind the proposed status. The paragraph stating the listing recommendation (both in the Executive Summary and at the end on p. 6) would also be improved by reference to the general qualifying criteria, in this case geographic range.

In terms of content, I think some of the conclusions drawn about *T. oolitica*'s population size and trends go beyond empirical support. The report states or implies on more than one occasion that there has been a population decline. While this may or may not be true, I do not think the available evidence supports a conclusion that a population reduction has occurred. I agree with your suspicion that urban expansion and ongoing habitat fragmentation have likely reduced *T. oolitica*'s numbers, but the species has always been rare with too few sightings to make population estimates and the data that do exist show no change in the number of observations over time. Thus, available information must be interpreted to suggest some level of population stability. Given the species' apparent ability to subsist on small patches of human-altered habitat, I think creating a numerical link with human population change is unmerited.

I suggest that the presented population number (ca. 35,000) is in excess of any empirical or calculable figure. There have been fewer than 90 *T. oolitica* sightings over the past 75 or so years, despite there being at least three studies that have targeted the species and its being sought after by many herpetology hobbyists. Even for a secretive species in a habitat with many good hiding places, I would expect a higher number of observations if there were indeed 35,000 of them to find. I would caution against using Glenn Fried's observed numbers for even conservative calculations as these are so far deviant from any other observations. Further, I suggest that comparisons with other *Tantilla* species' densities are likely inappropriate given *T. oolitica*'s unique habitat requirements.

I agree with the reviewers that the appropriate criterion/ listing measure that qualifies *T. oolitica* for listing is "geographic range" because of severe fragmentation and a continuing decline in the area, extent and/or quality of habitat. It is clear that the areas being discussed are small enough that the species qualifies for listing based both on "extent of occurrence" and "area of occupancy" limits, but these numbers could be made more accurate. The authors acknowledge that the "extent of occurrence" calculation includes unsuitable habitat in Miami-Dade County. I

think the unsuitable habitat should be removed to more truly reflect the accepted range of the species.

"Area of occupancy" is a far more complicated calculation because it requires a more detailed understanding of *T. oolitica*'s distribution. *Tantilla oolitica*'s presence in the lower Keys was only recently verified and its adaptability to habitat modification is difficult to account for. The proposed "area of occupancy" includes a range of natural areas, including those infested with exotics, but does not appear to include residential areas where *T. oolitica* has also been found. The safest, least complicated way to deal with our insufficient knowledge would be to limit the listing criteria to B1ab(iii). If, however, additional criteria are desired, I recommend revising the "area of occupancy" calculation to remove the Long Pine Key area of Everglades National Park since there is no evidence of the species in that area and to include residential areas, at least those near natural areas.

I think the discussion of large (but unproven) subpopulations potentially existing at larger tracts like Key Largo and Zoo Miami is inappropriate speculation and unhelpful to the analysis. There is no evidence that 50% of the population occurs in any given patch. Further, even these comparatively large tracts are fragmented, containing barriers like roads and moats that limit/ prevent dispersal. I suggest this discussion be removed as it creates an unnecessary loophole that may compromise the protection this species requires.

I realize this is beyond the scope of my review, but I also wanted to state that while I applaud Florida's move toward utilizing the IUCN Red List criteria for the state-listing system, I am disappointed that it is not being used wholeheartedly. The IUCN has very clear and globally accepted criteria for ranking species as Critically Endangered, Endangered, or Vulnerable and I see no reason to not embrace terminology of the entire system.

Peer review #4 from Dr. Sam Telford

From: bludpara@netzero.net [mailto:bludpara@netzero.net]
Sent: Saturday, January 22, 2011 10:18 AM
To: Enge, Kevin
Subject: Tantilla oolitica review

22 Jan11

Kevin,

Attached is the review for Tantilla oolitica. It is brief, but given the paucity of information on the species, it's all I could do. Let me know if the attachment has problems - the older I get, the less confidence I have in electronic procedures!

Regards,

Sam

BIOLOGICAL STATUS REVIEW FOR THE RIM ROCK CROWNED SNAKE (*TANTILLA OOLITICA*)

Reviewers Comments

(1) Little is known of the biology of *Tantilla oolitica*, the rim rock crowned snake, because of its mode of life (largely fossorial) and fragmented distribution. The authors of the Executive Summary have had no alternative but to base their conclusions mostly upon speculation. Except for the recent herp survey begun by Zoo Miami personnel in 2004 and apparently continuing at present, the few specimens collected have apparently resulted from casual collecting in some of the disjunct sites from which the species is known. The total number of specimens obtained to date appears to be less than 50. This reviewer agrees with most of the conclusions contained in the Executive Summary, but is cautious on two of these: an assumption that the ecology of the species is similar to that of the southeastern crowned snake, *Tantilla coronata*, and the rather large estimates of population size. *Tantilla oolitica* is a product of very different selection pressures than those that shaped the ecology of *T. coronata*, especially those of climate, frequency of flooding due to tropical storms, predators, and characteristics of the substrate. On population size, there is really no way to estimate the numbers of individuals accurately without suitable field studies, probably utilizing a mark and release program based upon upon grids, drift fences, pitfall traps, and cover boards. This may not be practical except in those localities with little exposure to human activities. Accordingly, this reviewer believes that the authors of the Executive Summary did the best they could with the small amount of actual data available on the species.

(2) The opinions expressed in the BSR are reasonable and justified with the limited data available. Designation of *Tantilla oolitica* as a threatened species is highly appropriate in view of the never ending development of Dade and Monroe counties which can be thwarted for protection of the fauna only by the designation of as many areas as possible as permanently restricted and unavailable for development.

Sam R. Telford, Jr., Ph.D.

Letters and emails received during the solicitation of information from the public period of September 17, 2010 through November 1, 2010

Letter from Dustin Smith:

Pine Rockland Herp Surveys:

Zoo Miami has been conducting herp surveys on property for approximately 5 years, and our surveys have yielded 1 rim rock crowned snake, (*Tantilla oolitica*). Our lone *oolitica* was found in 2009 and was the first specimen ever found in a pitfall trap. This find was the most southern and western within Dade County, according to vouchered specimens at FLMNH.

Prior to our current herp surveys, there was 1 Indigo snake found in 1996 on zoo property, but there have been none seen since. We began conducting herp surveys in December 2004, using visual surveys as the only technique. This was done throughout zoo property and inside pine rocklands.

After 1 year of visual surveys, the zoo constructed two drift fences, each containing 6 funnel traps. These funnel traps have been checked 2 times each day, since July 2005, with an 11 month break following hurricane damage from multiple hurricanes. There has been approximately 1,200 hours spent checking these 2 traps from December 2004 to present. In January 2009, staff added 2 more drift fences with funnel traps and pitfall traps to zoo property. The 4 drift fences are placed on 4 different sections of pine rockland habitat within the 750 acres of zoo grounds.

There has been approximately 440 hours spent checking the new traps from Jan 2009 to present. In addition to the 1,640 hours spent checking traps since 2004, there has been over 50 hours spent conducting visual surveys within the pine rocklands and surrounding habitat. We will continue to conduct herp surveys on property and focus on finding more *Tantilla oolitica*. I am hoping that our surveys provide you with some additional information on this species.

Dustin Smith, Assistant Curator – Ectotherms
Zoo Miami
12400 SW 152nd Street
Miami, FL 33177

Email from Paula Halupa

From: Paula_Halupa@fws.gov
To: Imperiled; Haubold, Elsa
Cc: Dana_Hartley@fws.gov
Subject: Re: rimrock crowned snake
Date: Monday, November 01, 2010 4:32:52 PM
Attachments: Final.Report.July.10.2009.pdf
Importance: High

Hi Elsa,

Here is a final report from a study that we funded a few years ago on the rimrock crowned snake.

Talk to you soon,

-Paula

(See attached file: Final.Report.July.10.2009.pdf)
^^^
Paula J. Halupa
Fish and Wildlife Biologist
Listing, Candidate Conservation, and Recovery
U.S. Fish and Wildlife Service
South Florida Ecological Services Office
1339 20th Street
Vero Beach, FL 32960-3559

Assessment of the Status and Distribution of the Endemic Rim Rock Crowned Snake (*Tantilla oolitica*) in Miami-Dade and Monroe Counties, Florida

Final Report
Grant Agreement #401817G006

Kirsten N. Hines and Keith A. Bradley

July 10, 2009

Submitted by:
The Institute for Regional Conservation
22601 S.W. 152 Avenue, Miami, FL 33170
George D. Gann, Executive Director

Submitted to:
Paula Halupa
Fish and Wildlife Biologist
U.S. Fish and Wildlife Service
1339 20th Street
Vero Beach, FL 32960

Project Background:
The rim rock crowned snake (*Tantilla oolitica*) is one of three species of small, burrowing snakes within the genus *Tantilla* found in Florida. Of the more than 40 species of this genus extending from the southeastern United States down to northern Argentina in South America, *T. oolitica* has the most limited distribution (Wilson 1982, Scott 2004). Confined to the Miami Rock Ridge in southeastern Miami-Dade County and parts of the Florida Keys in Monroe County, this species has been greatly affected by the rapid urbanization of this area. By 1975 it had already made the Florida State list of threatened species and it is currently considered a candidate for the Federal Endangered Species List.

Traditionally, *T. oolitica* habitat included rockland hammocks and pine rocklands. Less than 2% of the pine rocklands on the Miami Rock Ridge currently remain (Snyder et. al 1990, USFWS 1999) and rockland hammocks both in Miami-Dade County and throughout the Florida Keys have been reduced to less than half their original extent and continue to face threat of development (Enge et. al 1997, USFWS 1999). Appropriately demonstrating the pressures faced by *T. oolitica*, the site where the original holotype was discovered, SW 27th Avenue and SW 24th Street in Miami, became the site of a supermarket shortly after this species was state listed (Porras and Wilson 1979).

Based on several observations of *T. oolitica* in disturbed areas and under piles of rubbish (ex. Porras and Wilson 1979, Bartlett 2002) and due to their small home range needs (Scott 2004), speculations are that the species may adapt well to living in an urbanized setting (Campbell 1978, 1992). The thought is that the species may persist if pertinent conservation areas exist and cities are structured to allow for green belts, parks and areas of low human density (Campbell 1978, 1992). It is difficult, however, to create management recommendations based on the little we know. In order to increase our knowledge of this secretive species, Grant Agreement #401817G006 between the U.S. Fish and Wildlife Service and The Institute for Regional Conservation was signed in November 2006 and grant modification #1 with appropriation #41420-1115-0000 for additional funding was signed in August 2008 to extend the survey to pursue a possible range extension for the species throughout the lower Florida Keys based on a sighting at Big Pine Key in December 2007. Study objectives were to (1) assess the current status and distribution of *T. oolitica* within its historic range; (2) increase our understanding of *T. oolitica*'s natural history and habitat requirements; and (3) develop management recommendations for this state listed species.

Project Methods:
Permits –
Permits were acquired from the Florida Department of Environmental Protection (# 5-08-03 and 5-09-18), the Miami-Dade County Parks and Recreation Department (# 103R), the State of Florida Fish and Wildlife Conservation Commission (# WX07099 and # LSSC-09-0151) and the U.S. Fish and Wildlife Service (# 41581-07-01 and # 41580-2009-019).

Cover Photo: Tantilla oolitica (rim rock crowned snake) captured at Dove Creek Hammock in May 2007, taken by IRC Biologist Kirsten Hines.

Background Research and Interviews –
Over 60 researchers, hobbyists and people in relevant careers were directly contacted for information on potential *T. oolitica* sightings. In addition, museums with known *T. oolitica* holdings were contacted for information on their specimens, Florida Natural Areas Inventory (FNAI) was contacted for relevant information in their files and a posting was placed on the "Field Herp Forum" (www.fieldherpforum.com). All information gathered on sightings was entered into a Microsoft Access database and was mapped using ArcGIS.

Coverboards –
Twelve conservation areas within *T. oolitica*'s historic range in Miami-Dade and Monroe counties were selected for repeated monitoring throughout this study. At least one and no more than three coverboard arrays were placed at each of these selected sites in late February and early March of 2007 for a total of 28 coverboard arrays. Each array consisted of three independently numbered 2X4-foot pieces of 1/2-inch thick plywood. Table 1 gives distribution details for the arrays and Figure 1 shows a map of the arrays in relation to all currently known *T. oolitica* sightings, though this includes an extension past Marathon which was the accepted southernmost range for the species at the time the board locations were chosen. The coverboard arrays were primarily placed in hammock habitat because the records available at the time indicated that this was the preferred habitat.

The coverboard arrays were left undisturbed from installation until May 2007 to allow for microhabitat development. Once monitoring began, boards were individually lifted by one person while at least one other person watched for fleeing wildlife and then searched beneath the board, taking care to rake through the leaf litter. All reptile and amphibian species found under the boards were recorded both by array and by individual board number. For the months of May and June 2007, all 28 coverboard arrays were checked monthly. Due to the frequent disturbance and low rainfall, however, the boards were believed to be too dry to be effectively utilized by *T. oolitica*. In order to address this issue, holes were drilled into all boards during June and July and the sampling regime was modified such that individual boards were checked once every other month. As a result, coverboard arrays in Miami-Dade County were monitored in May, June, July, September and November of 2007 and January, March and May of 2008. Monroe County coverboard arrays were monitored in May, June, August, October and December of 2007 and February and April of 2008.

Opportunistic Searches –
Opportunistic searches were conducted each month at one or both of the counties based on the schedule outlined above for coverboard monitoring. Searches consisted of all researchers and volunteers spreading out within an area and systematically searching beneath all moveable rocks, logs and other cover items. All amphibian and reptile species found during the survey period were recorded individually, though brown anoles (*Anolis sagrei*) are only reported when they were found under cover materials due to their abundance at most sites and more arboreal nature which distracted from *T. oolitica*

searching. A GPS location was recorded at the start of each survey period and time was recorded at the start and end of the search to standardize findings by search effort (person hours). With occasional exceptions, the conservation areas containing coverboard arrays were searched upon every visit. In addition, privately and publicly owned areas containing appropriate habitat within *T. oolitica*'s historic range were also searched as permission was granted. Additional opportunistic searches were done at various sites between Marathon and Key West in 2009 in response to a sighting on Big Pine Key in December 2007 that suggested their range might extend through the entire length of the Florida Keys. Table 2 provides an overview of all sites visited and associated search effort by person hours (see Figure 2 for mapped locations).

Project Results To Date:

Background Research and Interviews –

Data was collected for at least 80 sightings of *T. oolitica* (Table 3; mapped on Figure 3 as possible) between 1934 and 2009. Sources included 23 museum specimens, 3 FNAI records and 10 personal accounts from interviews. Most of the people contacted as potential sources responded, but had no data to contribute. There were occasional interviewees, however, who acknowledged having seen *T. oolitica*, but were uncooperative in divulging details. Most interviewees with sightings to report had information on one or two, but Glenn Freid, a former naturalist at Bill Sadowski Park and the Deering Estate, reported at least 41 sightings from his tenure at those parks 10-25 years ago. He saw a total of 15-20 at Bill Sadowski and 6-8 at the Deering Estate, but was unable to give an accurate estimate for a third site at which densities were high and he was confident that he was seeing some of the same individuals repeatedly. He reported consistently finding 1-10 at each visit to the latter site, with 12 being the maximum seen in any one day. This area of extreme density was an abandoned house on a lot between the two parks. The yard had several plywood boards strewn across it and he said they invariably had *T. oolitica* under them in densities of up to eight under a single board. This site was the only he knew of with those high numbers and unfortunately, the site was developed and no longer exists.

Another record of interest is the December 2007 report by Nathan Shepard from Big Pine Key. Historically Marathon has been considered the southernmost range for *T. oolitica.* A 1938 museum specimen, currently housed at the Milwaukee Public Museum, is recorded from Key West, but has generally been disregarded since the locality data was never verified and no further sightings were made in the Lower Florida Keys. This Big Pine Key sighting suggests that the locality data for the Key West specimen may be correct. At the very least, it indicates that the species' range may extend the entire length of the Keys and was the impetus for expanding this particular survey to include locations between Marathon and Key West.

Sixty-seven (67) recorded sightings had associated habitat data. Of these, 36 were from disturbed habitats (roadsides, vacant lots, trash piles) and 31 were from natural areas (hammock, pine rockland, or hammock ecotone). Within the natural area habitats, the majority of sightings were in hammock-pineland ecotone with at least 15 sightings attributed to this habitat type. Seven sightings were described as being from hammock,

three were attributed to pine rockland and the six to eight sightings from the Deering Estate were uncertainly distributed between these two habitat types.

Thirty-five (35) records had associated time of year data. The majority of findings were made between March and June with 24 of the observations occurring in this time period – 6 in March, 7 in April, 4 in May, 3 in June and another 4 attributed to the May to June period. The remaining observations were distributed throughout the other months of the year with only October having more than one observation for a total of three.

In terms of comparisons across years, the period from 1971 to 1990 had the highest number of observations at 18. Between 1930 and 1950 there were 6 reported observations; between 1951 and 1970 there were 6 reported sightings; and from 1991 to present there have been 12 reported sightings (current study included). Sightings reported with a range of years were not included in this calculation if the range did not fall entirely within the categories presented above.

Coverboards –
No individuals of *Tantilla oolitica* were found under coverboards. Two hundred sixty two (262) other amphibians and reptiles, representing seven different species (omitting species identified only to genus), were recorded beneath coverboards during this survey: 157 greenhouse frogs (*Eleutherodactylus planirostris*); 59 reef geckos (*Sphaerodactylus notatus*); 27 tropical geckos (*Hemidactylus mabouia*); 6 southeastern five-lined skinks (*Eumeces inexpectatus*); 5 ring-necked snakes (*Diadophis punctatus*); 3 brown anoles (*A. sagrei*); 2 Brahminy blind snakes (*Ramphotyphlops braminus*); 2 unidentified geckos (*Hemidactylus* sp.); and one unidentified toad (*Bufo* sp.). A shed snake skin the right size for *T. oolitica* was also discovered under a coverboard at Blue Heron Hammock in Marathon. The skin was sent to Paul Moler at the Florida Fish and Wildlife Conservation Commission (FFWCC) for identification aid and while he was reasonably sure it was from a ring-necked snake, he sent it to Trip Lamb at East Carolina University for definitive DNA testing. No results were ever received. A list of findings by location is found on Table 4.

Opportunistic Searches –
Two hundred thirty two (232) person hours (including 95.35 volunteer hours) were spent searching 52 different sites (Table 2 for list; Figure 2 for map) for this project. In addition to the 12 regularly visited sites containing the coverboard arrays, 26 additional locations within *T. oolitica*'s accepted historic range were searched (16 in Miami-Dade and 10 in Monroe counties), and 14 sites were searched within the area of potential range extension between Marathon and Key West. Two *T. oolitica* were discovered using this method (details to follow) and 345 other amphibians and reptiles, representing 22 species (omitting species identified only to genus), were recorded during opportunistic searches: 77 greenhouse frogs (*E. planirostris*); 65 reef geckos (*S. notatus*); 61 tropical geckos (*H. mabouia*); 48 brown anoles (*A. sagrei*); 18 Brahminy blind snakes (*R. braminus*); 15 ring-necked snakes (*D. punctatus*); 11 black racers (*Coluber constrictor*); 9 unidentified geckos (6 *Hemidactylus* sp. & 3 *Sphaerodactylus* sp.); 8 green anoles (*Anolis carolinensis*); 6 southeastern five-lined skinks (*E. inexpectatus*); 5 green iguanas (*Iguana*

iguana); 3 yellow rat snakes (*Elaphe obsoleta*); 3 mangrove salt marsh snakes (*Nerodia clarkii compressicauda*); 2 southern toads (*Bufo terrestris*); 2 Florida box turtles (*Terrapene carolina bauri*); 2 six-lined racers (*Cnemidophorous sexlineatus*); 2 narrow-mouthed toads (*Gastrophryne carolinensis*); 2 ashy geckos (*Sphaerodactylus elegans*) and single individuals of cottonmouth snake (*Agkistrodon piscivorous*), Puerto Rican crested anole (*Anolis cristatellus*), bark anole (*Anolis distichus*), gopher tortoise (*Gopherus polyphemus*), leopard frog (*Rana sphenocephala*) and Florida brown snake (*Storeria dekayi victa*). Due to the abundance of brown anoles, this species was only reported when discovered beneath cover items as opposed to its usual distribution amongst trees and shrubs. A complete list of the findings by location can be found on Table 4.

Two *T. oolitica* were discovered during opportunistic searches for this project. One was seen by Kirsten Hines, but not captured, at the Barnacle Historic State Park on May 8, 2007 at 8:45 am. This individual was discovered in a loose pile of rock and moist, dark soil about 15 cm beneath the surface. The location was within hammock just a few meters away from the coverboard array for this site. The second *T. oolitica* was discovered by Michael Rochford at 9:50 am on May 25, 2007 at Dove Creek Hammock on Key Largo. This individual was less than ten centimeters beneath the surface and was coiled under a rotting board in moist, dark soil. This location was also in hammock just a few meters from the middle coverboard array for this site. The temperature at the capture site was 25˚C and the relative humidity was 80%. The snake itself was 19.9 cm total length and weighed 1.65 g. Sex was not determined for this individual. A shed snake skin the right size for *T. oolitica* was also discovered at Dove Creek Hammock in the general vicinity and time of this discovery, but DNA results were never received to confirm whether it was the target species or a similarly sized ring-necked snake.

Discussion:

Assessment of Current Status and Distribution –

The rim rock crowned snake (*Tantilla oolitica*) continues to be an elusive species with limited number of sightings. Many Florida herpetologists (professional and hobbyists) interviewed had never seen one despite attempts to find them. Of the few who had, only one or two could report having seen more than one or two snakes, with only one subject claiming to regularly find them and at relatively high densities. Despite the consistently low numbers, an average of only 10 sightings per 20 year period, the number of sightings has been highest in the last two 20 year periods. The period from 1930 to 1950 and from 1951 to 1970 each had only 6 sightings while it jumped to 18 between 1971 and 1990 and is at 12 for the period between 1991 to present. These data indicate that the population is either stable or on the increase, though interpretations are difficult given the scarcity of data and influencing factors. The apparent increase in number of sightings may be an artifact of the urban expansion and population growth that South Florida continues to experience, which began in this era of increased sightings. Given the fact that only two individuals were found in over a year of searching and that there are currently no known areas to find the species consistently nor in numbers greater than one, it is doubtful that the population is increasing.

In terms of distribution, given the Big Pine Key sighting in December of 2007 and the museum specimen from Key West, it seems likely that their distribution runs the entire extent of the Florida Keys. While our searches between Marathon and Key West failed to uncover further individuals, there was plenty of ideal habitat in the area and there were a couple of leads that suggest further searching should be done. While acquiring permission to work at sites both in Key West and on Big Pine Key, indirect sources claimed to know someone who thought they had seen a *T. oolitica* on each of those islands – near the Airport Road entrance of Little Hamaca Park in Key West and at the "boneyard" area of the National Key Deer Refuge on Big Pine Key. Both areas were unsuccessfully searched during our Lower Keys survey and no further information could be collected from the direct sources to verify the sightings one way or the other. At the very least, *T. oolitica*'s accepted range must be extended to Big Pine Key given Nathan Shepard's documented finding.

Natural History and Habitat Requirements –
Sightings over time suggest that *T. oolitica* is an adjustable species. It has occurred in a range of habitats over the years, including rockland habitats, dump sites and various urban and agricultural landscapes. The *T. oolitica* discovered during this study were both in hammock habitat with closed canopy and loose, dark, moist soil. The site of the Big Pine Key finding was at an informal dump in pineland-hammock ecotone where carpet and old ply boards seemed to maintain moisture in an otherwise dry landscape. Louis Porras, a researcher who worked with the species in the 1970's (see Porras & Wilson 1979), was concerned that the ongoing lowering of South Florida's water table may negatively affect this species, driving them from pine rockland habitats as conditions become too dry for centipedes and beetle larvae, their main food sources. Whether food supply is the driving force or not, moisture seemed to be a common habitat factor for the most recent sightings. A study on centipede and beetle larvae distribution and numbers may help clarify this trend.

The fact that one of the sightings in this study was at the Barnacle Historic State Park, a site containing less than 4 acres of hammock and the smallest property regularly monitored in the study, verifies previous assumptions (Campbell 1992) that this species is capable of adjusting to urban landscapes. This sighting verifies that very little habitat is required for their survival, presumably because they have minimal home range size requirements. We hoped to address home range to some extent through our mark recapture protocol, but no animals were recaptured despite repeated searches at areas where individuals were previously caught.

Much research is still required to understand the natural history of this species, but their low frequency of discovery is an impediment. Two of the historic sightings for this species were based on roadkill sightings wherein they had been in the stomach of a coral snake. Stomach flushing coral snakes, dissecting roadkill coral snakes and/or dissecting coral snake museum specimens from within *T. oolitica*'s range may yield more information on *T. oolitica* itself.

Management Recommendations –
Tantilla oolitica is currently listed as Threatened by the State of Florida and is a candidate for listing under the Federal Endangered Species Act. One incentive of this project was to determine whether the species should be elevated from candidate status to Federally "Threatened" or "Endangered". Following this study, we feel that the species should be considered for listing at this time. According to a U.S. Fish and Wildlife publication (USFWS 2009), "*A species is added to the list when it is determined to be endangered or threatened because of any of the following factors:*

- *The present or threatened destruction, modification or curtailment of its habitat or range;*
- *Overutilization for commercial, recreational, scientific, or educational purposes;*
- *Disease or predation;*
- *The inadequacy of existing regulatory mechanisms;*
- *The natural or manmade factors affecting its survival.*"

The first and the last factors in this list are applicable to *Tantilla oolitica*. While the species appears adaptable to urban expansion, there is likely a limit to that tolerance. Miami-Dade County is one of the densest and most rapidly developing areas in the nation with rockland habitats being amongst the most threatened. Given the low numbers of this species, hitting the threshold of their tolerance to urbanization could lead to extinction, particularly given that they are endemic to this region and a large portion of their range is within this expansion zone.

Also relating to the rapid urbanization of the area, human demands on the natural water supply may also impact this species, making it a candidate for the last item in the above list of factors. It is unclear to what extent this species is dependent upon the water table, but moisture does appear to be a factor in their distribution and likely that of their food source. Restoration efforts in the greater Everglades region may reduce this factor in the future, but water levels throughout the area are a concern at the moment and may directly impact this species.

Another management recommendation includes future monitoring. Their range clearly needs to be extended to Big Pine Key, but extension all the way to Key West requires confirmed reports. Increased captures would also aid in establishing a population estimate and status assessment, as well as increasing our knowledge on their natural history. Opportunistic searches were most effective in this study, but coupling them with drift fences would likely increase success. Establishing permanent arrays in areas of optimal habitat within their range, including the Lower Keys, would likely be the most efficient way to monitor this species. Accomplishing a mark-recapture or radio telemetry study on *T. oolitica* would greatly increase our knowledge on this species and its needs.

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Table 1. Coverboard array distribution by location and habitat type.

Location	Habitat Type	UTM Easting	UTM Northing
Miami-Dade County			
Bill Sadowski Park	Hammock	568426	2832418
Bill Sadowski Park	Hammock	568504	2832511
Bill Sadowski Park	Pine-Hammock Ecotone	568418	2832284
Matheson Hammock Park	Hammock	572846	2840617
Matheson Hammock Park	Hammock	572717	2840546
R. Hardy Matheson Preserve	Hammock	572317	2838799
The Barnacle Historic State Park	Hammock	575910	2845537
The Deering Estate at Cutler	Hammock	569842	2834185
The Deering Estate at Cutler	Pine Rockland	569540	2834372
The Deering Estate at Cutler	Pine-Hammock Ecotone	569548	2834271
Monroe County			
Blue Heron Hammock	Hammock	494535	2734720
Blue Heron Hammock	Hammock	494648	2734780
Crocodile Lake National Wildlife Refuge	Hammock	569996	2795405
Crocodile Lake National Wildlife Refuge	Hammock	567620	2790450
Crocodile Lake National Wildlife Refuge	Hammock	564077	2785375
Curry Hammock State Park	Hammock	498889	2735751
Curry Hammock State Park	Hammock	500055	2736262
Curry Hammock State Park	Hammock	501254	2736738
Dove Creek Hammock	Hammock	550167	2768474
Dove Creek Hammock	Hammock	550270	2768622
Dove Creek Hammock	Hammock	550665	2769091
Key Largo Hammocks Botanical State Park	Hammock	570517	2795862
Key Largo Hammocks Botanical State Park	Hammock	570352	2797901
Key Largo Hammocks Botanical State Park	Pine-Hammock Ecotone	570955	2796838
Lignumvitae Key Botanical State Park – Teatable Hammock on Upper Matecumbe Key	Hammock	534813	2754152
Long Key State Park	Hammock	518025	2744944
Long Key State Park	Hammock	518401	2745386
Long Key State Park	Hammock	518376	2745376

Table 2. Sites visited during this project with associated person hours of survey effort.

Location	Total Person Hours
Big Pine Key - "Boneyard"	4.25
Big Pine Key - 19th St	0.2
Big Pine Key - 610 Wilder Rd	0.25
Big Pine Key - Ixora Dr	3.5
Big Pine Key - South St (dumping site)	0.5
Big Pine Key - Watson Hammock	5
Cudjoe Key - by dump	5
Cudjoe Key - off Valencia Rd	2.25
Fat Deer Key - Curry Hammock SP	9.75
Islamorada - Hammock Fragment near Founder's Park	1
Key Largo - Crocodile Lake NWR	12.5
Key Largo - Dove Creek Hammocks	12.75
Key Largo - Hammock E of Blue Runner b/n Bonito & Dolphin Aves.	0.75
Key Largo - Hammock NE of Blue Runner & Bonito	1.5
Key Largo - Hammock SE of Blue Runner & Bonito	1.5
Key Largo - John Pennecamp SP	1
Key Largo - Road Median (by power pole B3-213)	0.75
Key Largo - Road Median (MM 97.5)	1.5
Key Largo Hammocks Botanical SP	14
Key Largo Ranger Station (ENP)	1.5
Key West - Little Hamaca Park, Airport Rd & Bahama Dr.	1.25
Key West - Little Hamaca Park, main entrance area	2
Key West Botanical Garden - hammock	3.5
Key West Botanical Garden - stone wall	2.5
Long Key - Long Key SP	6.75
Lower Sugarloaf Key - Sugarloaf Blvd	3
Marathon - Blue Heron Hammock	7.5
Marathon - Crane Point	1.5
Marathon - Hammock Fragment	1
Miami - A.D. Barnes	2
Miami - Alice Wainwright	2.25
Miami - Barnacle Historic SP	11
Miami - Bill Sadowski Park	13
Miami - Boy Scout Property on 157 & 256	2
Miami - Camp Owaissa Bauer	3.5
Miami - County Health Facility Property	2.25
Miami - Deering Estate	16.75
Miami - George Avery Pineland (IRC)	2.25
Miami - Hattie Bauer	2
Miami - Kendall Indian Hammock Park	2
Miami - Ludlam Pineland	1
Miami - Matheson Hammock Park	13.75
Miami - Ned Glenn Pineland	2.5

Table 2 Continued.

Location	Total Person Hours
Miami - R. Hardy Matheson Preserve	9.25
Miami - Seminole Wayside Park	2
Miami - Silver Palm Groves	2.25
Miami - Simpson Park	2.25
Miami - USDA Property on Old Cutler Rd	4
Miami - Vizcaya	3
Miami - Whispering Pines Hammock	2
No Name Key	15.1
Upper Matecumbe - Lignumvitae Botanical SP	7.75
Total:	232.3

Table 3. Summary of *Tantilla oolitica* sightings based on literature and interviews, not including two sightings from this study.

Year	Month	Source	Location	Habitat (# if more than 1)
1934	January	Museum of Comparative Zoology, Harvard (H. Loomis)	Chapman Field, Old Cutler Road, Miami-Dade County, FL	
1938		Milwaukee Public Museum (H. Jungmann)	Key West, Monroe County, FL*	
1941	March	Carnegie Museum of Natural History (G. R. Campbell)	Coral Gables, Miami-Dade County, FL	
1945	March	Natural History Museum, U Kansas (G. Knowles)	Coral Gables, Miami-Dade County, FL	
1948	May	National Museum of Natural History (W.E. Haast)	Kendall, Miami-Dade County, FL	
1950	March	Florida Museum of Natural History, U Florida (W. Auffenberg)	SW Miami, Miami-Dade County, FL	Pasture
1951	April	Museum of Zoology, U Michigan (A. Shwartz)	SR-905 on North Key Largo, Monroe County, FL	
1954	October	Natural History Museum, U Kansas (R. Patterson)	Miami-Dade County, FL	
1955	April	Florida Museum of Natural History, U Florida (D. Paulson)	SW 27 Avenue & SW 24 Street, Miami-Dade County, FL	Vacant lot (2)
1955	April	Natural History Museum of Los Angeles County (D. Paulson)	SW 27 Avenue & SW 24 Street, Miami-Dade County, FL	Vacant lot
1969	April	Florida Museum of Natural History, U Florida (T. Krakauer)	Old Cutler Road & Red Road, Miami-Dade County, FL	
1976	September	Florida Museum of Natural History, U Florida (local resident)	near Marvin D. Adams Waterway, Key Largo, Monroe County, FL	
1978	February	Florida Museum of Natural History, U Florida (L.D. Wilson)	Grassy Key, Monroe County, FL	
1978	June	Florida Museum of Natural History, U Florida (J. Fernandez)	Grassy Key, Monroe County, FL	Field adjacent to hammock
1979	July	Robert Ehrig	Tavernier, Key Largo, Monroe County, FL	Hammock
1979	November	Robert Ehrig	Plantation Key, Monroe County, FL	Secondary Hammock

Table 3 Continued.

Year	Month	Source	Location	Habitat (# if more than 1)
1980's	May - June	Roger Hammer	Bill Sadowski Park, Miami-Dade County, FL	Hammock-pineland ecotone
1980	March	Florida Museum of Natural History, U Florida (T. Barken)	US 1 & SW 154 Ave, Miami-Dade County, FL	
1981	March	Florida Museum of Natural History, U Florida (L. Porras)	Old Cutler Road b/t SW 168 St & SW 178 St, Miami-Dade County, FL	
1982	May	Florida Natural Areas Inventory (K. Achor)	North Creek Hammocks (MM 105), Key Largo, Monroe County, FL	Sidewalk
1982	May - June	Robert Line	Ned Glenn Pineland, Miami-Dade County, FL	Pine rockland
1982	May - June	Robert Line	West of Old Cutler slough in the Palmetto Bay area, Miami-Dade County, FL	Pine rockland
1983	April	Florida Natural Areas Inventory (M. Minno)	Arch Creek Park, Miami-Dade County, FL	Hammock
1983-1998		Glenn Freid	Old Cutler and SW 176th St, Miami-Dade County, FL	Abandoned house and lot (20+)
1983-1998		Glenn Freid	Bill Sadowski Park, Miami-Dade County, FL	Hammock-pineland ecotone (15-20)
1983-1998		Glenn Freid	Deering Estate at Old Cutler, Miami-Dade County, FL	Hammock-pineland ecotone and Pine rockland (6-8 total at site)
1984	May	Florida Natural Areas Inventory (P. Moler)	SR-905 on North Key Largo, Monroe County, FL	Roadside
1984	May - June	Robert Line	Ludlam Pineland area, Miami-Dade County, FL	
1985-2005		Joe Burgess	SW 112th Ave, Miami-Dade County, FL	Disturbed pine rockland, vacant lot
1985	March	Florida Museum of Natural History, U Florida (A. Nielson)	old entrance to John Pennekamp Coral Reef State Park, Key Largo, Monroe County, FL	Private backyard
1988	May	Florida Museum of Natural History, U Florida	Upper Matacumbe Key (MM 81), Islamorada, Monroe County, FL	40 feet from shore
1988	Summer	John Decker	Lower Matecumbe Key, Monroe County, FL	Disturbed hammock and edge

Table 3 Continued.

Year	Month	Source	Location	Habitat (# if more than 1)
1989	June	Florida Museum of Natural History, U Florida (G. Dalrymple)	Old Cutler Road, Miami-Dade County, FL	
1992	August	Barbara Gouldener	Bill Sadowski Park, Miami-Dade County, FL	Hammock edge by playground
1992-1996		Jim Duquesnel	Bonito Ave, Key Largo, Monroe County, FL	Roadside (2 *T. oolitica* inside roadkill coral snake)
1992-1996		Jim Duquesnel	SR-905 on North Key Largo, Monroe County, FL	Roadside (1 *T. oolitica* inside roadkill coral snake)
1996	April	Florida Museum of Natural History, U Florida (J. Decker)	Marathon b/t 36 St & 39 St, Vaca Key, Monroe County, FL	Hammock and edge
1997		Joseph Nemec	John Pennekamp Coral Reef State Park, Key Largo, Monroe County, FL	Maintenance area of park
2000	June	Florida Museum of Natural History, U Florida (J. Decker)	Marathon, Vaca Key, Monroe County, FL	Roadside
2002	October	John Decker	Marathon, Vaca Key, Monroe County, FL	Hammock and edge
2004	October	Florida Museum of Natural History, U Florida (J. Duquesnel)	Blue Runner St, Key Largo, Monroe County, FL	Roadside - roadkill
2007	December	Nathan Shepard	Big Pine Key, Monroe County, FL	Abandoned lot/ trash heap

* This specimen generally disregarded in the literature because location data was never verified.

Table 4. Reptile and amphibian species recorded during surveys, listed by location and method of discovery (OS = Opportunistic Survey; CB = Coverboard).

Location	Common Name	Scientific Name	Quantity	Total	Method
Miami - Dade County					
A.D. Barnes Park	ring-necked snake	*Diadophis punctatus*	1	3	OS
	greenhouse frog*	*Eleutherodactylus planirostris*	1		OS
	southeastern five-lined skink	*Eumeces inexpectatus*	1		OS
Alice Wainwright Park	greenhouse frog*	*Eleutherodactylus planirostris*	1	4	OS
	tropical gecko*	*Hemidactylus mabouia*	3		OS
Barnacle Historic SP	black racer	*Coluber constrictor*	1	22	OS
	greenhouse frog*	*Eleutherodactylus planirostris*	4		CB
	Brahminy blind snake*	*Ramphotyphlops braminus*	7		OS
	reef gecko	*Sphaerodactylus notatus*	8/1		OS/CB
	rim rock crowned snake	*Tantilla oolitica*	1		OS
Bill Sadowski Park	ring-necked snake	*Diadophis punctatus*	2	16	CB
	greenhouse frog*	*Eleutherodactylus planirostris*	7		CB
	tropical gecko*	*Hemidactylus mabouia*	1/6		OS/CB
Camp Owaissa Bauer	greenhouse frog*	*Eleutherodactylus planirostris*	1	1	OS
The Deering Estate at Cutler	toad sp.	*Bufo sp.*	1	48	CB
	southern toad	*Bufo terrestris*	2		OS
	black racer	*Coluber constrictor*	1		OS
	ring-necked snake	*Diadophis punctatus*	5/2		OS/CB
	yellow rat snake	*Elaphe obsoleta*	1		OS
	greenhouse frog*	*Eleutherodactylus planirostris*	2/10		OS/CB
	southeastern five-lined skink	*Eumeces inexpectatus*	3		CB
	gopher tortoise	*Gopherus polyphemus*	1		OS
	tropical gecko*	*Hemidactylus mabouia*	2		CB
	Brahminy blind snake*	*Ramphotyphlops braminus*	2/1		OS/CB
	reef gecko	*Sphaerodactylus notatus*	7/8		OS/CB
Hattie Bauer Hammock	gecko sp.*	*Hemidactylus sp.*	1	3	OS
	reef gecko	*Sphaerodactylus notatus*	2		OS
Kendall Indian Hammocks	ring-necked snake	*Diadophis punctatus*	1	4	OS
	tropical gecko*	*Hemidactylus mabouia*	1		OS
	Brahminy blind snake*	*Ramphotyphlops braminus*	1		OS
	Florida brown snake	*Storeria dekayi victa*	1		OS
Ludlam Pineland	Brahminy blind snake*	*Ramphotyphlops braminus*	2	3	OS
	reef gecko	*Sphaerodactylus notatus*	1		OS
Matheson Hammock Park	black racer	*Coluber constrictor*	1	44	OS
	ring-necked snake	*Diadophis punctatus*	2/1		OS/CB
	greenhouse frog*	*Eleutherodactylus planirostris*	7/16		OS/CB
	tropical gecko*	*Hemidactylus mabouia*	1		CB
	Brahminy blind snake*	*Ramphotyphlops braminus*	1		OS
	reef gecko	*Sphaerodactylus notatus*	5/9		OS/CB
	Florida box turtle	*Terrapene carolina bauri*	1		OS
Ned Glenn Pineland	southeastern five-lined skink	*Eumeces inexpectatus*	1	1	OS
R. Hardy Matheson Preserve	brown anole*	*Anolis sagrei*	3	19	OS
	black racer	*Coluber constrictor*	1		OS
	ring-necked snake	*Diadophis punctatus*	1		OS

Table 4 Continued.

Location	Common Name	Scientific Name	Quantity	Total	Method
R. Hardy Matheson Preserve	greenhouse frog*	*Eleutherodactylus planirostris*	5		CB
	southeastern five-lined skink	*Eumeces inexpectatus*	1		OS
	tropical gecko*	*Hemidactylus mabouia*	3/1		OS/CB
	Brahminy blind snake*	*Ramphotyphlops braminus*	1/1		OS/CB
	reef gecko	*Sphaerodactylus notatus*	2		OS
Seminole Wayside Park	reef gecko	*Sphaerodactylus notatus*	2	2	OS
Simpson Park	brown anole*	*Anolis sagrei*	4	11	OS
	ring-necked snake	*Diadophis punctatus*	1		OS
	greenhouse frog*	*Eleutherodactylus planirostris*	3		OS
	tropical gecko*	*Hemidactylus mabouia*	3		OS
South Dade County Health Facility	black racer	*Coluber constrictor*	1	2	OS
	tropical gecko*	*Hemidactylus mabouia*	1		OS
USDA Chapman Field Station on Old Cutler	Puerto Rican crested anole*	*Anolis cristatellus*	1	3	OS
	ring-necked snake	*Diadophis punctatus*	1		OS
	southeastern five-lined skink	*Eumeces inexpectatus*	1		OS
Vizcaya Museum & Gardens	brown anole*	*Anolis sagrei*	5	7	OS
	greenhouse frog*	*Eleutherodactylus planirostris*	1		OS
	reef gecko	*Sphaerodactylus notatus*	1		OS
Whispering Pines Hammock	tropical gecko*	*Hemidactylus mabouia*	2	4	OS
	reef gecko	*Sphaerodactylus notatus*	2		OS
Upper Florida Keys					
Blue Heron Hammock	green anole	*Anolis carolinensis*	1	31	OS
	bark anole*	*Anolis distichus*	1		OS
	brown anole*	*Anolis sagrei*	2		OS
	greenhouse frog*	*Eleutherodactylus planirostris*	2/10		OS/CB
	southeastern five-lined skink	*Eumeces inexpectatus*	2/2		OS/CB
	tropical gecko*	*Hemidactylus mabouia*	4/3		OS/CB
	gecko sp.*	*Hemidactylus sp.*	1		OS
	Brahminy blind snake*	*Ramphotyphlops braminus*	1		OS
	reef gecko	*Sphaerodactylus notatus*	1/1		OS/CB
Crane Point, Marathon	reef gecko	*Sphaerodactylus notatus*	1	1	OS
Crocodile Lake NWR	brown anole*	*Anolis sagrei*	3/1	40	OS/CB
	greenhouse frog*	*Eleutherodactylus planirostris*	9/18		OS/CB
	tropical gecko*	*Hemidactylus mabouia*	1		CB
	gecko sp.*	*Hemidactylus sp.*	1		OS
	reef gecko	*Sphaerodactylus notatus*	1/6		OS/CB
Curry Hammock SP	Florida cottonmouth	*Agkistrodon piscivorous*	1	49	OS
	brown anole*	*Anolis sagrei*	5		OS
	black racer	*Coluber constrictor*	1		OS
	greenhouse frog*	*Eleutherodactylus planirostris*	6/23		OS/CB
	southeastern five-lined skink	*Eumeces inexpectatus*	1		CB
	tropical gecko*	*Hemidactylus mabouia*	2/2		OS/CB
	gecko sp.*	*Hemidactylus sp.*	1		CB
	green iguana*	*Iguana iguana*	3		OS
	reef gecko	*Sphaerodactylus notatus*	1/3		OS/CB

Table 4 Continued.

Location	Common Name	Scientific Name	Quantity	Total	Method
Dove Creek Hammock	green anole	*Anolis carolinensis*	2	79	OS
	brown anole*	*Anolis sagrei*	10		OS
	black racer	*Coluber constrictor*	1		OS
	greenhouse frog*	*Eleutherodactylus planirostris*	15/15		OS/CB
	tropical gecko*	*Hemidactylus mabouia*	5/5		OS/CB
	reef gecko	*Sphaerodactylus notatus*	6/19		OS/CB
	rim rock crowned snake	*Tantilla oolitica*	1		OS
Hammock E of Blue Runner b/t Bonito & Dolphin (Key Largo)	green anole	*Anolis carolinensis*	1	2	OS
	greenhouse frog*	*Eleutherodactylus planirostris*	1		OS
Hammock Fragment in Marathon (MM 57)	tropical gecko*	*Hemidactylus mabouia*	1	1	OS
Hammock Fragment near Founder's Park, Islamorada	tropical gecko*	*Hemidactylus mabouia*	2	3	OS
	reef gecko	*Sphaerodactylus notatus*	1		OS
Hammock NE of Blue Runner & Bonito (Key Largo)	greenhouse frog*	*Eleutherodactylus planirostris*	3	6	OS
	reef gecko	*Sphaerodactylus notatus*	3		OS
Hammock SE of Blue Runner & Bonito (Key Largo)	tropical gecko*	*Hemidactylus mabouia*	1	2	OS
	reef gecko	*Sphaerodactylus notatus*	1		OS
John Pennecamp SP	brown anole*	*Anolis sagrei*	1	6	OS
	greenhouse frog*	*Eleutherodactylus planirostris*	1		OS
	tropical gecko*	*Hemidactylus mabouia*	1		OS
	reef gecko	*Sphaerodactylus notatus*	3		OS
Key Largo Hammocks Botanical SP	brown anole*	*Anolis sagrei*	4	44	OS
	black racer	*Coluber constrictor*	1		OS
	ring-necked snake	*Diadophis punctatus*	1		OS
	greenhouse frog*	*Eleutherodactylus planirostris*	4/16		OS/CB
	tropical gecko*	*Hemidactylus mabouia*	2		OS
	yellow rat snake	*Elaphe obsoleta*	1		OS
	reef gecko	*Sphaerodactylus notatus*	6/9		OS/CB
Key Largo Ranger Station (Everglades NP)	brown anole*	*Anolis sagrei*	7	12	OS
	greenhouse frog*	*Eleutherodactylus planirostris*	3		OS
	reef gecko	*Sphaerodactylus notatus*	2		OS
Key Largo Road Median (by power pole B3-213)	green anole	*Anolis carolinensis*	1	2	OS
	greenhouse frog*	*Eleutherodactylus planirostris*	1		OS
Key Largo Road Median (MM 97.5)	greenhouse frog*	*Eleutherodactylus planirostris*	2	3	OS
	tropical gecko*	*Hemidactylus mabouia*	1		OS
Lignumvitae Key Botanical SP - Teatable Hammock & Klopp Tract	green anole	*Anolis carolinensis*	1	30	OS
	brown anole*	*Anolis sagrei*	1/1		OS/CB
	black racer	*Coluber constrictor*	1		OS
	ring-necked snake	*Diadophis punctatus*	1		OS
	greenhouse frog*	*Eleutherodactylus planirostris*	2/7		OS/CB
	tropical gecko*	*Hemidactylus mabouia*	6/2		OS/CB
	Brahminy blind snake*	*Ramphotyphlops braminus*	3		OS
	reef gecko	*Sphaerodactylus notatus*	1/3		OS/CB

Table 4 Continued.

Location	Common Name	Scientific Name	Quantity	Total	Method
	Florida box turtle	*Terrapene carolina bauri*	1		OS
Long Key SP	brown anole*	*Anolis sagrei*	3/1	42	OS/CB
	greenhouse frog*	*Eleutherodactylus planirostris*	6/26		OS/CB
	tropical gecko*	*Hemidactylus mabouia*	1/4		OS/CB
	gecko sp.*	*Hemidactylus sp.*	1		CB
Lower Florida Keys					
Watson Hammock, Big Pine Key	greenhouse frog*	*Eleutherodactylus planirostris*	1	13	OS
	tropical gecko*	*Hemidactylus mabouia*	3		OS
	green iguana*	*Iguana iguana*	1		OS
	reef gecko	*Sphaerodactylus notatus*	8		OS
Valencia Rd., Cudjoe Key	ashy gecko*	*Sphaerodactylus elegans*	2	2	OS
Sugarloaf Blvd., Lower Sugarloaf Key	yellow rat snake	*Elaphe obsoleta*	1	3	OS
	tropical gecko*	*Hemidactylus mabouia*	1		OS
	mangrove salt marsh snake	*Nerodia clarkii compressicauda*	1		OS
No Name Key	green anole	*Anolis carolinensis*	1	10	OS
	greenhouse frog*	*Eleutherodactylus planirostris*	2		OS
	tropical gecko*	*Hemidactylus mabouia*	5		OS
	gecko sp.*	*Hemidactylus sp.*	1		OS
	gecko sp.	*Sphaerodactylus sp.*	1		OS
Little Hamaca Park - main entrance (Key West)	black racer	*Coluber constrictor*	1	7	OS
	tropical gecko*	*Hemidactylus mabouia*	3		OS
	mangrove salt marsh snake	*Nerodia clarkii compressicauda*	2		OS
Key West Botanical Garden - hammock	greenhouse frog*	*Eleutherodactylus planirostris*	1	6	OS
	tropical gecko*	*Hemidactylus mabouia*	3		OS
	leopard frog	*Rana sphenocephala*	1		OS
Key West Botanical Garden - stone wall	green anole	*Anolis carolinensis*	1	4	OS
	ring-necked snake	*Diadophis punctatus punctatus*	1		OS
	tropical gecko*	*Hemidactylus mabouia*	1		OS
	gecko sp.	*Sphaerodactylus sp.*	1		OS
Ixora & 15th, Big Pine Key	black racer	*Coluber constrictor*	1	5	OS
	greenhouse frog*	*Eleutherodactylus planirostris*	1		OS
	tropical gecko*	*Hemidactylus mabouia*	3		OS
Dumpsite, Cudjoe Key	tropical gecko*	*Hemidactylus mabouia*	2	3	OS
	gecko sp.	*Sphaerodactylus sp.*	1		OS
"Boneyard", Big Pine Key	six-lined racer	*Cnemidophorus sexlineatus*	2	5	OS
	narrow-mouth toad	*Gastrophryne carolinensis*	2		OS
	green iguana*	*Iguana iguana*	1		OS

*Introduced species

Figure 1. Coverboard locations shown in relation to presently known *Tantilla oolitica* sightings. Marathon was considered the southernmost extent of the species' range at the beginning of this study when the coverboard arrays were established.

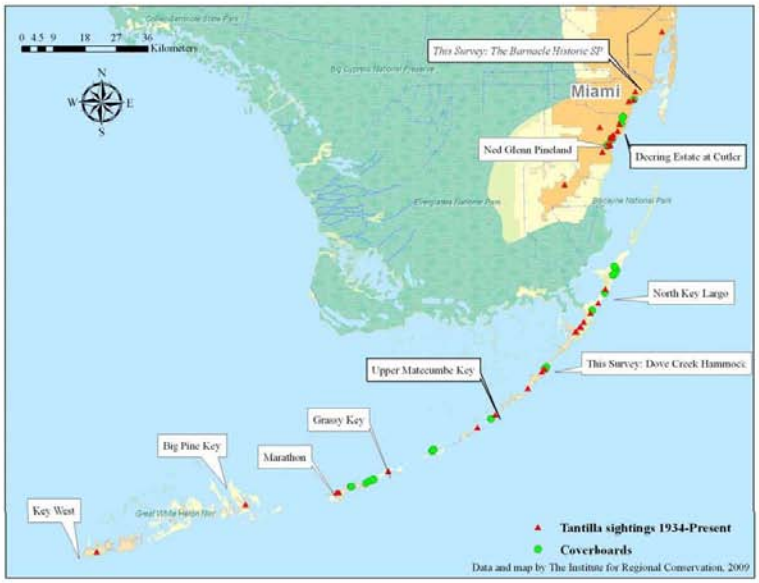

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Figure 2. Sites surveyed during this project, shown in relation to presently known *Tantilla oolitica* sightings. Survey locations coded based on timing and frequency of visits (see legend below).

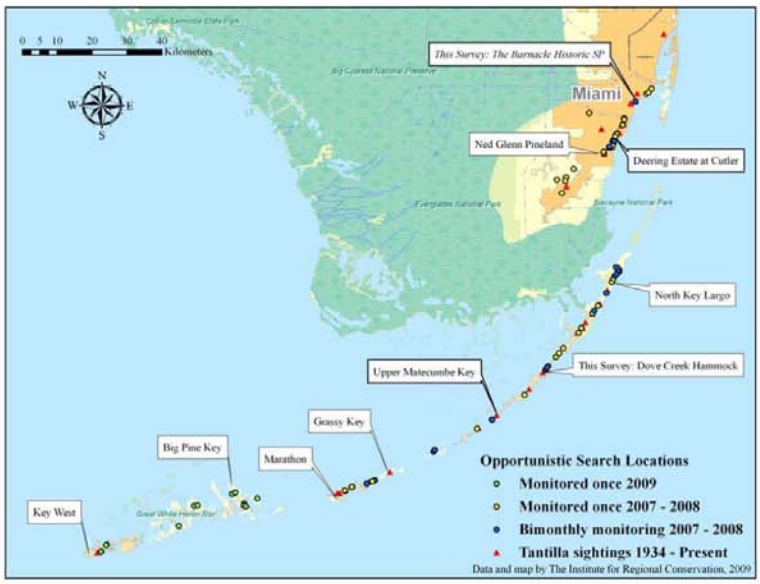
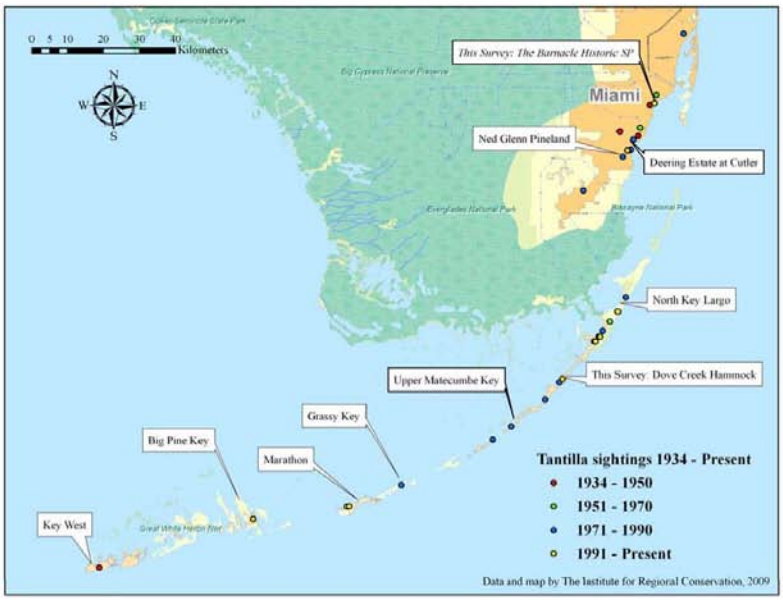


Figure 3. Presently known locations of *Tantilla oolitica* sightings coded by 20 year increments.



Copy of the Rim Rock crowned snake BSR draft report that was sent out for peer review

Biological Status Review
for the
Rim Rock Crowned Snake
(*Tantilla oolitica*)

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 1 September 2010. Public information on the status of the rim rock crowned snake (*Tantilla oolitica* Telford, 1966) 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 rim rock crowned 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 rim rock crowned snake met at least 1 criterion for listing as Threatened. Based on the BRG findings, literature review, and information received from the public (*see* Appendix 2), staff recommends listing the rim rock crowned snake as a state-designated Threatened species.

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

BIOLOGICAL INFORMATION

Taxonomic Classification – The rim rock crowned snake (*Tantilla oolitica*) was described by Telford (1966) from an adult male collected in April 1955. This species was elevated from a sub-species of the southern crowned snake (*T. coronata wagneri*). The closest taxonomic relative to the rim rock crowned snake is the southern crowned snake (*T. coronata*) (Ernst and Ernst 2003), although spatially the Florida crowned snake (*Tantilla relicta*) is more proximal.

Life History and Habitat Requirements – The natural habitats of the rim rock crowned snake are pine rockland and rockland hammock (also called tropical hammock) in the Miami area and Florida Keys, but there are records from human-altered habitats such as roadsides, vacant lots, and pastures with shrubby growth and slash pines (*Pinus elliottii*) (Duellman and Schwarz 1958, Campbell and Moler 1992, Hines and Bradley 2009). Rockland hammock is a hardwood forest that represents an advanced successional stage of pine rockland that results from

the absence of fire. Pine rocklands have sparse soils; refugia are provided by holes and crevices in the limestone, piles of rock rubble, and pockets of organic matter accumulating in solution holes and shallow depressions in the oolitic limestone (Enge et al. 2003). In the Lower Keys, however, the surface is mostly limestone, and a fine sandy loam exists only in scattered shallow depressions. The Upper Keys (Soldier to Big Pine Key) are composed of Key Largo limestone, a coral reef that apparently grew in the Pamlico Sea (Neill 1957), whereas the Lower Keys are Miami limestone; these limestone outcroppings have apparently been continuously exposed during rising sea levels over the last 14,000 years (Robbin 1984). The largest outcrop is of oolitic Miami limestone along the Miami Rock Ridge, which extends from Miami through Homestead to the Long Pine Key area of Everglades National Park (ENP), but this species has only been documented from the eastern rim of Miami oolite. The rim rock crowned snake is a fossorial species that inhabits shallow soil over oolitic limestone formations, and it can sometimes be found in rotten stumps and under anthropogenic surface detritus (including a pile of damp clothing and rotten boards), fallen logs, and rocks (Duellman and Schwarz 1958, Bartlett 2002, Hines and Bradley 2009, Rochford et al. 2010, Yirka et al. 2010). Eroded cavities in the limestone may provide underground refugia (Porras and Wilson 1979). It apparently comes to the surface after rains (Porras and Wilson 1979; J. Decker, pers. commun.), possibly because of flooding of its underground refugia.

Nothing is known regarding its reproduction, longevity, or diet, but if it is similar to the closely related southeastern crowned snake (*Tantilla coronata*), then the rim rock crowned snake probably matures at 2 years old and may live to be to at least 5 years old in the wild (Todd et al. 2008). Because of warmer temperatures and the longer growing season in South Florida, sexual maturity may be attained earlier in the rim rock crowned snake. There may be 3 eggs in a clutch, and 2 clutches could be produced annually (*see* Ernst and Ernst 2003). Prey probably consists of centipedes, insects, and other small invertebrates (Ernst and Ernst 2003). Two rim rock crowned snakes were found inside a road-killed eastern coral snake (*Micrurus fulvius*) (Hines and Bradley 2009). It may be preyed upon by the slender brown scorpion (*Centruroides gracilis*), which is abundant in the same habitats (Porras and Wilson 1979).

Population Status and Trend – There is no information, but the population has undoubtedly declined as sites previously occupied by the species have been developed. The vacant lot in Marathon where several rim rock crowned snakes have been found under trash was cleared in the past decade and turned into a ball park (Florida Museum of Natural History records), and the lot with an abandoned house in Miami where 1–10 snakes could consistently be found each visit has been developed (Hines and Bradley 2009). The most recent mainland records are from The Barnacle Historic State Park in 2007 (Hines and Bradley 2009) and Zoo Miami (formerly Miami Metrozoo) property in 2009 (*see* Appendix 2). The most recent records from the Keys are 1988 on Upper and Lower Matecumbe keys, 1998 on Grassy Key, 2002 on Vaca Key (Marathon), and 2007 on Big Pine Key and Key Largo (Hines and Bradley 2009, museum and Florida Natural Areas Inventory records). Records compiled by Hines and Bradley (2009) show 6 observations in 1930–50, 6 in 1951–70, 18 in 1971–90, and 12 since 1991 (does not include the Zoo Miami record).

Geographic Range and Distribution – On the mainland, the rim rock crowned snake is known from various localities in Miami, including Brownsville, Coconut Grove, Coral Gables, Cutler, Cutler Ridge, Kendall, Leisure City, North Miami, and Perrine (Duellman and Schwartz 1958, museum and Florida Natural Areas Inventory records) (Fig. 1). The species also occurs in

the Upper and Middle Keys (Fig. 1), but the only record from the Lower Keys (Key West in 1938), has been considered questionable (Telford 1966, Campbell and Moler 1992). However, the discovery of a specimen on Big Pine Key in 2007 (Yirka et al. 2010) confirms the occurrence of the species in the Lower Keys.

Quantitative Analyses – Endries et al. (2009) ran a population viability analysis (PVA) model on all potential habitat and a PVA model on potential habitat occurring on managed areas only (56.9% of the habitat identified). Assuming no changes, the probability that the rim rock crowned snake would become extinct during the next 100 years was 0% in both models. However, a sea level rise due to climate change could significantly impact this species, particularly in the Florida Keys. Most of the land that is 80 cm (31 inches) above sea level in the Keys was once vegetated by pine rockland or rockland hammock habitat (the preferred habitats for the rim rock crowned snake), which are flooded by salt water only during significant storm surges.

BIOLOGICAL STATUS ASSESSMENT

Threats – Enge et al. (2003) provided descriptions of the rockland habitats of South Florida, their threats, and their wildlife communities. Human development and clearing of these 2 habitats, particularly in the Miami area, has severely fragmented populations of the rim rock crowned snake; these rockland habitats are now embedded in a matrix of agricultural and residential landscapes (O'Brien 1998). Approximately 98% of the original Miami Rock Ridge pinelands outside of ENP has been lost (Snyder et al. 1990). Many of the rockland hammocks on the Keys and mainland were cleared for agriculture, firewood, and charcoal in the 1800s, and almost all pinelands were clear cut by 1950 (Snyder et al. 1990).

Seawater surges from hurricanes and tropical storms in the relatively xeric Keys, whose rockland habitats may become flooded with salt water for 1–3 days following hurricanes (Enge et al. 2003), may impact rim rock crowned snake populations in the short term. Hurricanes strike South Florida about every 3 years (Gentry 1974), and there is a 1 in 7 chance of Dade or Monroe County being struck in any given year (Fernald and Purdum 1992). 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. In 1965, Hurricane Betsy passed over the Upper Keys as a Category 3 hurricane, and a 1.8-m (6-foot) storm surge flooded much of Miami. If climate change results in rising sea levels, much of the habitat of the rim rock crowned snake could become inundated, particularly in the Keys. In

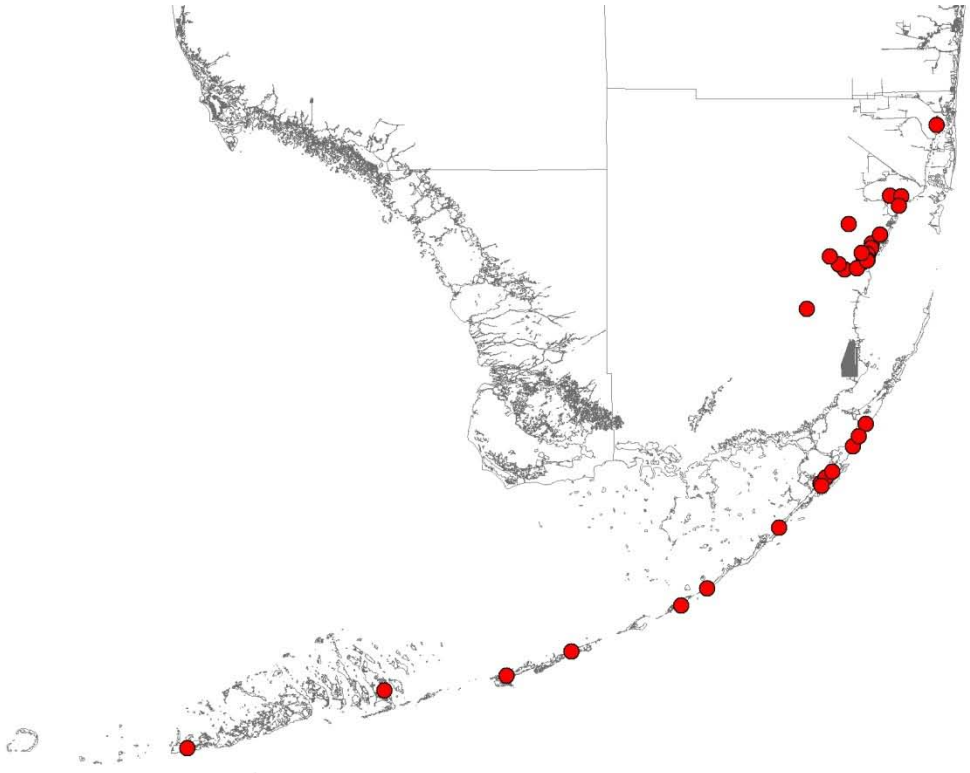


Fig. 1. Locality records from museums, FNAI, and the literature for the rim rock crowned snake.

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). 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.

The red imported fire ant (*Solenopsis invicta*) has invaded South Florida and the Keys, and predation by this nonnative species has been suggested as a reason for declines in some oviparous snake populations in the Southeastern Coastal Plain (Mount 1981). Because of its fossorial nature and small size, the rim rock crowned snake would appear to be particularly susceptible to fire ants. In a study conducted in the Lower Keys, transects with the highest probability of the presence of fire ants were those closest to roads and with the largest amount of development within a 150-m radius (Forys et al. 2002). The increasing numbers of introduced lizard species in the Miami area and on some of the Keys (Meshaka et al. 2004) might have some impact. The Cuban treefrog (*Osteopilus septentrionalis*), cane toad (*Rhinella marina*), and several of the introduced lizard species are capable of preying on small snakes (Meshaka et al. 2004). Some introduced lizard species, especially the litter dwellers, might compete for food with the rim rock crowned snake.

Statewide Population Assessment – Findings from the BRG are included in Biological Status Review Information tables.

LISTING RECOMMENDATION

The BRG concluded from the biological assessment that the rim rock crowned snake met at least 1 criterion for listing as Threatened. Based on the BRG findings, literature review, and information received from the public (*see* Appendix 2), staff recommends listing the rim rock crowned snake as a state-designated Threatened species.

SUMMARY OF THE INDEPENDENT REVIEW

To be added after peer review.

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Biological Status Review Information
Findings

Species/taxon: Rim Rock Crowned Snake
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	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 and 11.0% increase in Miami-Dade County since 2000 and limits on development of rockland habitats	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% and 10.4% human population increase in Monroe and Miami-Dade counties, respectively, in next 10 years and limits on development or rockland habitats	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)	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	248 mi^2	E	Y	Beth Stys pers. commun. GIS estimate based on 2003 FWC Landcover Data
(b)2. Area of occupancy < 2,000 km^2 (772 mi^2)	140.4 km^2, including Long Pine Key in Everglades National Park	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	Severely fragmented	S	Y	Snyder et al. (1990), Cox et al. (1994), Strong and Bancroft (1994), Bancroft et al. (1995), O'Brien (1998)
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	P	Y	Monroe County (1999), Zwick and Carr (2006)
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	No evidence of extreme fluctuations	S	N	
(C) Population Size and Trend				
Population size estimate to number fewer than 10,000 mature individuals AND EITHER	>10,000 mature individuals	S	N	Semlitsch et al. (1981), Mushinsky and Witz (1993), Franz et al. (1995), Todd et al. (2008), G. Freid's observations in Hines and Bradley (2009), GIS analysis of potential habitat by B. Stys (FWC)
(c)1. An estimated continuing decline of at least 10% in 10 years or 3 generations, whichever is longer (up to a maximum of 100 years in the future) OR		S	Y	Monroe County (1999)
(c)2. A continuing decline, observed, projected, or inferred in numbers of mature individuals AND at least one of the following:		P	Y	
a. Population structure in the form of EITHER	The Key Largo subpopulation and a few subpopulations in the Miami area might each contain >1,000 mature individuals	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	No evidence of extreme fluctuations	S	N	
(D) Population Very Small or Restricted, EITHER				

(d)1. Population estimated to number fewer than 1,000 mature individuals; OR	>10,000 mature individuals	S	N	See Criterion C
(d)2. Population with a very restricted area of occupancy (typically less than 20 km^2 [8 mi^2]) or number of locations (typically 5 or fewer) such that it is prone to the effects of human activities or stochastic events within a short time period in an uncertain future	140.4 km2, including Long Pine Key in Everglades National Park	E	N	
(E) Quantitative Analyses				
e1. Showing the probability of extinction in the wild is at least 10% within 100 years	0% probability from PVA	E	N	Endries et al. (2009)

Initial Finding (Meets at least one of the criteria OR Does not meet any of the criteria)	Reason (which criteria are met)
Threatened	B1 + 2ab(iii)
Is species/taxon endemic to Florida? (Y/N)	Y
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 + 2ab(iii)

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 or longevity records are available for the species, but data are available from South Carolina for the closely related southeastern crowned snake. Assuming demographics of these 2 species are similar, sexual maturity is attained in 2 years, and the species may live to be 5 years old in the wild (Todd et al. 2008). However, the rim rock crowned snake lives in a subtropical climate, so sexual maturity may occur earlier. We infer a mean generation length of 4 years.

Sub-criterion A2. – We assume that the rim rock crowned snake population has declined as the human population has increased, resulting in habitat loss and degradation from residential and commercial development, but the exact relationship is unknown. According to the U.S. Census Bureau, Miami-Dade County's human population increased by 11.0% from 2000 through 2009, whereas Monroe County's population decreased by 8.1% during the same time period. 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), and most of the remaining hammocks on the Miami Rock Ridge are not in danger of being cleared because they are now Miami-Dade County parks. The largest hammock on the Miami Rock Ridge, Brickell Hammock, was cleared in the early 1900s to build Miami, but >50% of the county's hammocks still remain (Snyder et al. 1990). Cox et al. (1994) identified about 375 pine rockland stands totaling nearly 1,780 ha outside of ENP in 1990, and about 50% of these stands were in public ownership. In the Keys, however, most hammocks are privately owned and are in demand for commercial and residential development. The number of dwelling units (permanent and seasonal) that can be permitted in Monroe County has been controlled by the Rate of Growth Ordinance adopted by Monroe County in 1992, which was developed as a response to the inability of the road network to accommodate a large-scale hurricane evacuation in a timely fashion (http://www.monroecounty-fl.gov/pages/MonroeCoFL_Emergency/LMSplan/ch02.pdf). In 1991, 34.4% of the land area in the unincorporated portion of the Keys, excluding offshore islands, consisted of privately owned vacant land, whereas 33.7% was in conservation land (Monroe County 1999). The amount of habitat necessary to sustain a population of this species is unknown, but small rockland habitat fragments surrounded by unsuitable habitat may no longer support populations. However, many of the larger rockland fragments are now in public ownership or protected from development. It is difficult to determine reductions in area of occupancy resulting from declines in habitat quality, because rim rock crowned snakes have been found in altered habitat, such as partially cleared vacant lots. Because of the small size of many of these rockland fragments and their location in an urban setting, management by prescribed fire is often not an option, but there is no evidence that the resulting community is unfavorable for the species; in fact, most records of this species from natural habitats have come from rockland hammocks or the edges of hammocks and pinelands (Cox and Kautz 2000, Hines and Bradley 2009). Collection for pets is not a significant threat because of its small size, specialized diet, and fossorial habits. Populations might be affected by introduced taxa and competitors.

Sub-criterion A3. – Three generations from 2010 would 2022. By the Year 2020, Miami-Dade County's population is projected to increase by 10.4%, whereas 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 by Zwick and Carr (2006). Of the potential habitat identified using GIS analysis, 61.3% 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. Even in highly urbanized Miami, rim rock crowned snake populations are likely to persist. The species has been found on the following protected tracts of land in Miami: Arch Creek Memorial Park, Bill Sadowski Park, Charles Deering Estate at Cutler, Ludlam Pineland, Miami Zoo, and Ned Glenn Pineland.

Sub-criterion B1. – The total land area of the Florida Keys, which consists of ca. 1,700 islands, is ca. 248 mi^2)(Beth Stys pers. commun.). The land area of Miami-Dade County, including unsuitable habitat in the Everglades, is 5,038 km^2 (1,945 mi^2). The extent of occurrence is <5,400 km^2 (2,100 mi^2).

Sub-criterion B2. – A GIS analysis of potential habitat for the species identified 140.4 km^2 (54.2 mi^2) of potential habitat (B. Stys, FWC, pers. commun. 2010), which we will assume is equivalent to the area of occupancy. However, this analysis included Long Pine Key in Everglades National Park, where rim rock crowned snakes have never been recorded. The predominant FWC 2003 land-cover classes that comprised most of the potential habitat were tropical hardwood hammock (48.2 km^2; 18.6 mi^2), pinelands (42.1 km^2; 16.3 mi^2), exotic plants (38.5 km^2; 14.9 mi^2), hardwood hammocks and forest (7.1 km^2; 2.7 mi^2), and dry prairie (3.2 km^2; 1.2 mi^2). Based upon future development of privately owned vacant lands, which comprise 34.4% of the area on the 38 main keys along U.S. 1 (Monroe County 1999), we project a continuing decline in area of occupancy, extent of habitat, and number of

mature individuals. Of the potential identified for the species, 5,429 ha (13,414 acres) are privately owned. A severely fragmented population has to have more than half of the individuals or the occupied habitat area in small and isolated patches incapable of sustaining viable populations. On the mainland, sites where snakes have been found are widely scattered, and several sites have been lost to development. In the Keys, the species inhabits islands all the way from Key Largo to at least Big Pine Key and possibly Key West. Many of the islands are now connected by bridges, but these bridges are unsuitable dispersal corridors for individuals, and we assume that their dispersal capability across water is minimal. Animals had to colonize these islands at some time, but the colonization probably occurred during lower sea levels when many islands were connected. The greatest distances between nearest known subpopulations in the Keys would be from Big Pine to Key West (40 km), Upper Matecumbe Key to Grassy Key (30 km), and Vaca Key to Big Pine Key (23 km). On the mainland, some subpopulations are much closer, but there can be no dispersal between them because the intervening habitat is completely developed. *Tantilla* will attempt to cross paved roads (Enge and Wood 2002), so minor roads may not be barriers to movement between habitat fragments. In a study of 5 radioactive-tagged peninsula crowned snakes (*Tantilla relicta neilli*) in Putnam County, the maximum home range size was 626 m^2, and the average distance traveled daily by the most active snake was 4.3 m (Franz et al. 1995). Clearing for agriculture and residential development has resulted in the loss of 98% of the original Miami Rock Ridge pinelands outside of ENP (Snyder et al. 1990). O'Brien (1998) identified 420 pine rockland fragments totaling 1,524 ha, and only 14% were in public ownership, although 6 of the 7 largest sites were owned by Miami-Dade County. Private lands in the Keys contain 453 patches of rockland hammock; the average size is 4.7 ha, with 52.5% of them being <1 ha in size (Cox et al. 1994). The Upper Keys lost 41.2% of its original 4,816 ha of forest, and the acreage in large fragments (>100 ha) decreased by 84% (Bancroft et al. 1995). The area from central Key Largo through Long Key lost 65.8% of its forests, and the original 35 large forest fragments had increased to 850 small fragments in 1991 (Strong and Bancroft 1994). Much of the northern half of Key Largo is protected within state and federal preserves, so it has lost only 29.7% of its forests, but the original 11 forest fragments increased to 165 in 1991 (Strong and Bancroft 1994). We infer that the population is severely fragmented, consisting of subpopulations on various islands and rockland fragments in Miami-Dade County that are separated by inhospitable habitat. However, the BRG discussed whether >50% of the population occurs in large subpopulations on Key Largo, Big Pine Key, Miami Zoo and adjacent lands, Charles Deering Estate at Cutler, and possibly a few other large tracts of land. If so, the population cannot be considered severely fragmented. However, we do not know how many small patches of habitat are inhabited by the species and the minimum size of habitat that can support a viable population. We suspect that 8 ha (20 acres) of habitat might be enough to support a viable population, but we did not know how many habitat fragments were this large and their total combined acreage (assuming all these fragments had snake populations).

Criterion C – No data on population densities exist for the rim rock crowned snake. Other *Tantilla* species attain high population densities (Semlitsch et al. 1981, Mushinsky and Witz 1993, Franz et al. 1995, Enge 1997, Todd et al. 2008). We are uncertain if the relatively few records that exist for the species means that it is uncommon, occurring at low population densities, or that it is secretive and usually inaccessible in oolitic substrate. Surveys for the species have been unsuccessful or found $\leq$2 individuals (e.g., Enge et al. 2004, Hines and Bradley 2009, Appendix 2). However, G. Freid, a former Miami-Dade County naturalist, reported finding up to 8 individuals under a single plywood board in an abandoned lot in Miami (*see* Hines and Bradley 2009). If we are conservative and assume a very low population density of only 0.4 snakes/ha (1 snake/acre), then the 14,042 ha (34,697 acres) of potential habitat identified using GIS analysis (B. Stys, FWC, pers. commun.) would contain ca. 35,000 snakes. Of this potential habitat, 8,613 ha (21,283 acres) are on conservation lands or preserves and easements. Of course, all potential habitat is probably not occupied by the species. The Barnacle Historic State Park, which contains only 1.6 ha (4 acres) of hammock, still supports a population (Hines and Bradley 2009). The recent discovery of a specimen on Zoo Miami property is significant because this property and the adjacent Larry and Penny Thompson Memorial Park and 2 U.S. government facilities total ca. 780 ha (1,900 acres) of natural and disturbed habitats unfragmented by major roads. The recent discovery on Big

Pine Key is also significant because it contains 1,000 ha (2,472 acres) of potential habitat (B. Stys, FWC, pers. commun. 2010), and much of the habitat is protected in the National Key Deer Refuge. If we assume a population density of 0.4 snakes/ha, then both of these sites would have subpopulations >1,000 mature individuals.

Appendix 1. Review 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 public comments.

Letter and comments submitted by Dustin Smith:

Pine Rockland Herp Surveys:

Zoo Miami has been conducting herp surveys on property for approximately 5 years, and our surveys have yielded 1 rim rock crowned snake, (*Tantilla oolitica*). Our lone *oolitica* was found in 2009 and was the first specimen ever found in a pitfall trap. This find was the most southern and western within Dade County, according to vouchered specimens at FLMNH.

Prior to our current herp surveys, there was 1 Indigo snake found in 1996 on zoo property, but there have been none seen since. We began conducting herp surveys in December 2004, using visual surveys as the only technique. This was done throughout zoo property and inside pine rocklands.

After 1 year of visual surveys, the zoo constructed two drift fences, each containing 6 funnel traps. These funnel traps have been checked 2 times each day, since July 2005, with an 11 month break following hurricane damage from multiple hurricanes. There has been approximately 1,200 hours spent checking these 2 traps from December 2004 to present. In January 2009, staff added 2 more drift fences with funnel traps and pitfall traps to zoo property. The 4 drift fences are placed on 4 different sections of pine rockland habitat within the 750 acres of zoo grounds.

There has been approximately 440 hours spent checking the new traps from Jan 2009 to present. In addition to the 1,640 hours spent checking traps since 2004, there has been over 50 hours spent conducting visual surveys within the pine rocklands and surrounding habitat. We will continue to conduct herp surveys on property and focus on finding more *Tantilla oolitica*. I am hoping that our surveys provide you with some additional information on this species.

Dustin Smith, Assistant Curator – Ectotherms
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APPENDIX 3. **Information and comments received from independent reviewers.**

Will be added after peer review.