Supplemental Information for the Striped Mud Turtle

(Lower Keys Population) 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 Dr. Whitfield Gibbons

From: Whit Gibbons
To: Imperiled
Cc: Turner, Bill
Subject: RE: Striped mud turtle (Lower keys pop.) Draft BSR Report
Date: Tuesday, January 25, 2011 4:15:49 PM
Attachments: 3Biological Review Group Striped Mud Turtle.doc

Dr. Haubold – attached is my review of the biological status review of the striped mud turtle (Lower Keys population). Please let me know if you have any questions

– whit gibbons
J. Whitfield Gibbons
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University of Georgia
Savannah River Ecology Lab
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January 25, 2011
Peer review of the biological status review of the
Striped mud turtle (Lower Keys population)
by

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The biological information presented and the analysis of the data by the Biological Review Group for the Biological Status Review for the Striped Mud Turtle (*Kinosternon baurii*; Lower Keys Population) appears to be accurate. The assessment is as complete as feasible considering the limited biological study that has been conducted on the species in general and the Lower Keys populations in particular. The five-member review group is well qualified to make the assessment. The Lower Keys populations of striped mud turtles appear to have a high potential for decline and local extirpation based on the available data and demographic assumptions. However, the recommendation that the striped mud turtle populations in the Lower Keys be removed from Florida's list of Threatened species appears justified on the basis of the strict interpretation of the listing criteria, in that the identified populations do not constitute a distinct subspecies and “does not meet the definition of an isolated population (significant and discrete population of a species).”

Peer review #2 from Dr. John Iverson

From: John Iverson
To: Imperiled
Cc: Turner, Bill
Subject: Re: Striped mud turtle (Lower keys pop.) Draft BSR Report
Date: Sunday, January 02, 2011 10:03:51 AM

Dear Colleagues:

I have read carefully the Biological Status Review of the Lower Keys population of K. baurii. The
literature review is thorough, the interpretation of those data is completely appropriate, and I totally
support the conclusions and recommendations of the Committee. I would make only one possible suggestion, and that would be an addition to Appendix I, on the calculation of generation time. I concur that 17.5 years is a reasonable estimate (as is 30 years as life expectancy). As further support
of this long generation time, you might cite the generation time of K. flavescens (28 yrs Iverson 1991),
the sister taxon to the clade including baurii and subrubrum (Serb et al. 2001). Given its
more southerly location compared to flavescens, generation would be expected to be a bit shorter, just
as the committee has noted. However, if anything, the estimate for baurii might be a little low.

To summarize, I agree with the committee that the Lower Keys populations are in peril, they do not
appear distinctive enough from the peninsular populations to warrant special protection.

John
Dr. John B. Iverson
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Copy of the Striped mud turtle BSR draft report that was sent out for peer review

Biological Status Review
for the
Striped Mud Turtle (Lower Keys Population)
(*Kinosternon baurii*)

EXECUTIVE SUMMARY

The Florida Fish and Wildlife Conservation Commission (FWC) directed staff to evaluate all species listed as Endangered, Threatened or Species of Special Concern as of 1 September 2010. Public information on the status of the Lower Keys population of the striped mud turtle was sought from September 17 through November 1, 2010. A five-member biological review group (BRG) met on November 9-10, 2010. Group members were Bill Turner (FWC lead), Chris Lechowicz (Sanibel-Captiva Conservation Foundation), Peter Meylan (Eckerd College), Paul Moler (independent consultant), and Travis Thomas (FWC) (Appendix 1). In accordance with rule 68A-27.0012 F.A.C, the BRG was charged with evaluating the biological status of the Lower Keys population of the striped mud turtle using criteria included in definitions in 68A-1.004, F.A.C., and following protocols in the *Guidelines for Application of the IUCN Red List Criteria at Regional Levels (Version 3.0)* and *Guidelines for Using the IUCN Red List Categories and Criteria (Version 8.1)*. Please visit http://myfwc.com/WILDLIFEHABITATS/imperiledSpp_listingprocess.htm to view the listing process rule and the criteria found in the definitions.

The BRG concluded from the biological assessment that the Lower Keys population of the striped mud turtle met multiple criteria for listing. Because the Lower Keys population of the striped mud turtle is not a sub-species and does not meet the definition of isolated population (significant and discrete population of a species), FWC staff recommends that the Lower Keys population of the striped mud turtle be removed from Florida's list of Threatened species. This work was supported by a Conserve Wildlife Tag Grant from the Wildlife Foundation of Florida.

BIOLOGICAL INFORMATION

Taxonomic Classification – Although striped mud turtles from the Lower Keys were formerly considered to be a distinct sub-species (Stejneger 1925, Uzzell and Schwartz 1955), more recent morphological and molecular studies (Iverson 1978, Lamb and Lovich 1990, Karl and Wilson 2001) have suggested that Lower Keys specimens are not sufficiently distinct to justify taxonomic recognition.

Life History and Habitat Requirements – Life history and habitat parameters are summarized rangewide by Ernst and Lovich (2009), and for the state of Florida by Wilson et al. (2006). In the Lower Keys, where freshwater habitats are extremely limited, Dunson (1981) captured striped mud turtles in small, ephemeral freshwater ponds and brackish water ponds with salinities below 15 ppt. Man-made mosquito control ditches, with longer hydroperiods, also supported high numbers. Rangewide, the species utilizes terrestrial habitats for nesting, migration between ponds (especially males), and aestivation during dry weather (Wilson et al. 2006). In the Lower Keys, turtles also move onto land to escape drying brackish ponds, which become too saline when water levels recede (Dunson 1992). Though not studied in the Keys, the species' varied diet elsewhere includes insects, worms, snails, algae, seeds, and the remains of vertebrates (e.g., small fishes and amphibians) that are scavenged (Wilson et al. 2006, Ernst and Lovich 2009). Most data about striped mud turtle reproduction have been generated from sites north of the Keys, especially the Florida Peninsula. Iverson (1979) estimated that females reach maturity in about 6 years; males may mature somewhat younger (Wilson et al. 2006). Longevity in the wild is unknown, but based on captive records (Wilson et al. 2006) and data for the closely related *K. subrubrum* (Meshaka and Gibbons 2006), 40 years is a reasonable estimate. Although nesting has been recorded in most months of the year in peninsular Florida, peak activity seems to occur in the fall, with a secondary peak in early summer (Iverson 1979 Wilson et al. 1999, Meshaka and Blind 2001); the extent to which this pattern might be altered in the Lower Keys is unknown. Females may move hundreds of meters from wetlands to nest (Mushinsky and Wilson 1992; Wilson 1996; Wilson et al. 1999); most lay 2-4 clutches of 1-6 eggs each per year (Iverson 1977, Wilson et al. 1999, Meshaka and Blind 2001, Wilson et al. 2006).

Population Status and Trend – Insufficient data are available to document current status and trend quantitatively. The species is known only from mostly small populations (dozens to a few hundred: Dunson 1992) on 11 islands in the Lower Keys (see Geographic Range and Distribution). It can be inferred from the level of development and habitat alteration on these keys that this regional population of the species has declined throughout the 20th century. Perhaps the most resounding example of this is Key West, where Garman (1891) found the species to be "tolerably abundant" in brackish ponds, yet Carr (1940) was unable to find any turtles during the late 1930s and believed the island's population to have been extirpated. Although construction of mosquito control ditches may have allowed some local populations to increase or recover in terms of numbers (Dunson 1992), this effect could be reversed quickly if some of these ditches are filled.

Geographic Range and Distribution – Striped mud turtles occur throughout Florida including the Florida Keys (Upper Keys, Middle Keys and Lower Keys). The listed Lower Keys population includes only striped mud turtles that occur from the western end of the Seven Mile Bridge to Key West. Specific records of this Lower Keys population, from east to west, are known for Big Pine Key, Little Torch Key, Middle Torch Key, Big Torch Key, Ramrod Key, Summerland Key, Cudjoe Key, Sugarloaf Key, Johnston Key, Stock Island, and Key West (Florida Natural Areas Inventory 2010).

Quantitative Analyses – Endries et al. (2009) developed a population viability analysis model for the Lower Keys population of the striped mud turtle, but, in the absence of specific microhabitat information, it used overly general habitat criteria that identified 2,539 ha (6,274 ac) of potential habitat. This is a vast (>90%) overestimate, as it includes both pine rockland and tropical hardwood hammock habitats, yet these principally are the upland matrix in which wetlands, the limiting habitat for the species, occur in the Lower Keys. The latter provide no more than ca. 200 ha (500 ac) of potential habitat for the turtle, and this habitat type is significantly threatened by several factors (see Threats) that affect hydroperiod and water quality.   The conclusion of the Endries et al. (2009) model, that there is 0% probability of extinction in the next 100 years, is thus untenable and unsupported.

BIOLOGICAL STATUS ASSESSMENT

Threats – The dependence of striped mud turtles on waters of low salinity (< 15 ppt: Dunson 1992) predispose it to decline and/or extirpation in the Lower Keys. Natural freshwater habitats in the Keys tend to be small (1- 50 acres) and precarious. Regardless of protective measures (regulatory on private lands, natural resource management on public lands), all such water bodies depend upon continued maintenance and protection of natural subsurface freshwater lenses. A myriad of factors associated with development and human habitation threaten these delicate lenses (Lazell 1989), both through direct reduction (hence, recession from the surface) and saltwater intrusion. For mud turtles, creation of artificial mosquito control ditches has partially offset the loss of smaller freshwater bodies, but these ditches do not assure perpetual habitat . Perhaps the most serious threat to all freshwater and brackish habitats in the Keys is sea level rise that is predicted to occur as a direct consequence of global warming (Field et. al. 2007). Because the striped mud turtle inhabits only a few islands in the Lower Keys (very small Extent of Occurrence and Area of Occupancy), the Lower Keys population is naturally vulnerable to threats by stochastic events. Although the species has survived many hurricanes, severe saltwater over wash from very large storms has the potential to increase salt content of fresh and brackish water ponds to an extent that would eliminate them as suitable for the mud turtle (Dunson 1992). Random events of severe pollution also provide a serious threat, as exemplified by the 2010 (MC 252) oil spill in the Gulf of Mexico. Protective booms or other measures would probably not prevent oiled waters from being cast over the entire Keys during a large hurricane; such a disaster would likely extirpate many local and regional populations of freshwater life, including mud turtles and their prey. Although not studied, it is likely (given that it is the rule for all turtles examined) that predators, particularly raccoons, take high percentages of mud turtle eggs as well as surviving young. This reduces the potential for already small, isolated populations of these turtles to recover from declines caused by any factors.

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

LISTING RECOMMENDATION

Because the Lower Keys population of the striped mud turtle is not a sub-species and does not meet the definition of isolated population (significant and discrete population of a species), FWC staff recommends that the Lower Keys population of the mud turtle be removed from Florida’s list of Threatened species.

SUMMARY OF THE INDEPENDENT REVIEW

To be added after the peer review.

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Biological Status Review Information
Findings

Species/taxon: Lower Keys population of the striped mud turtle
Date: November 9-10, 2010
Assessors: Chris Lechowicz, Peter Meylan, Paul Moler, Bill Turner and Travis Thomas
Generation length: 17.5

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]	insufficient data	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]	Inferred from habitat loss. Lower Keys have experienced extensive development with reduction of natural freshwater habitats in last half century. Populations on Key West and Stock Island likely highly reduced or eliminated.	I	Y	Dunson 1992
(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]	This is possible but there is little information to go on; perhaps can obtain growth projections from Monroe County. Much remaining habitat protected in National Key Deer Refuge.	I	N	
(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]	Highly likely, given patterns of past & projected development, alteration of natural habitats, sea level rise, salt water intrusion, decline in freshwater lens, hurricanes, other stressors	S	Y	Dunson 1992
[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	348 km^2, estimated area of 11 keys	E	Y	D. Jackson generated GIS polygon from Florida Natural Areas Inventory (FNAI) records

(b)2. Area of occupancy < 2,000 km^2 (772 mi^2)	<20 km^2, limited freshwater habitats, many artificial ditches, ponds.	E	Y	GIS habitat analysis by FWC/Stys
AND at least 2 of the following:				
a. Severely fragmented or exist in ≤ 10 locations	Fragmented-11 keys (small islands), naturally severely fragmented by intervening salt water (ocean), rare accidental transport possible but not significant.	O	Y	FNAI data, Dunson 1992
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	Projected decline, all categories, with loss of natural freshwater habitat related to development, sea level rise, stochastic events, fire ants	S	Y	Dunson 1992, Forys (Marsh rabbit info.)
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; extreme fluctuations unlikely in long-lived species;	O	N	
(C) Population Size and Trend				
Population size estimate to number fewer than 10,000 mature individuals AND EITHER	Likely less than 10,000 Even the densest known population (Summerland Key) is estimated to be in the hundreds; estimated 50 on undisturbed Johnson Key	S	Y	Dunson 1992
(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	see above Criterion A	S	Y	
(c)2. A continuing decline, observed, projected, or inferred in numbers of mature individuals AND at least one of the following:		S	Y	
a. Population structure in the form of EITHER (i) No subpopulation estimated to contain more than 1000 mature individuals; OR	Even the densest known population (Summerland Key) is estimated to be in the hundreds.	E	Y	Dunson 1992
(ii) All mature individuals are in one subpopulation	known from >10 islands	O	N	Dunson 1992, FNAI
b. Extreme fluctuations in number of mature individuals	No; extreme fluctuations unlikely in long-lived species	O	N	
(D) Population Very Small or Restricted, EITHER				
(d)1. Population estimated to number fewer than 1,000 mature individuals; OR	Uncertain, probably >1000-2000	E	N	Dunson 1992, FNAI
(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	<20 km^2, very restricted, remnant wetlands and drainage ditches (insert estimate if available)	S	Y	GIS habitat analysis by FWC/Stys

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

Initial Finding (Meets at least one of the criteria OR Does not meet any of the criteria)	Reason (which criteria are met)
Meets multiple criteria	A2+A4; B1+B2ab (i,ii,iii,iv,v); C1+ C2a(i); D2
Is species/taxon endemic to Florida? (Y/N)	N
If Yes, your initial finding is your final finding. Copy the initial finding and reason to the final finding space below. If No, complete the regional assessment sheet and copy the final finding from that sheet to the space below.	
Final Finding (Meets at least one of the criteria OR Does not meet any of the criteria)	Reason (which criteria are met)
Meets multiple criteria	A2+A4; B1+B2ab (i,ii,iii,iv,v); C1+ C2a(i); D2

1	Biological Status Review Information Regional Assessment Species/taxon:	Lower Keys population of the striped mud turtle
2	Date:	November 9- 10, 2010
3	Assessors:	Chris Lechowicz, Peter Meylan, Paul Moler,
4		Bill Turner and Travis Thomas
5		
6		
7		
8	Initial finding	
9		
10	2a. Is the species/taxon a non-breeding visitor? (Y/N/DK). If 2a is YES, go to line 18. If 2a is NO or DO NOT KNOW, go to line 11.	N
11	2b. Does the Florida population experience any significant immigration of propagules capable of reproducing in Florida? (Y/N/DK). If 2b is YES, go to line 12. If 2b is NO or DO NOT KNOW, go to line 17.	N
12	2c. Is the immigration expected to decrease? (Y/N/DK). If 2c is YES or DO NOT KNOW, go to line 13. If 2c is NO go to line 16.	
13	2d. Is the regional population a sink? (Y/N/DK). If 2d is YES, go to line 14. If 2d is NO or DO NOT KNOW, go to line 15.	
14	If 2d is YES - Upgrade from initial finding (more imperiled)	
15	If 2d is NO or DO NOT KNOW - No change from initial finding	
16	If 2c is NO or DO NOT KNOW- Downgrade from initial finding (less imperiled)	
17	If 2b is NO or DO NOT KNOW - No change from initial finding	No change
18	2e. Are the conditions outside Florida deteriorating? (Y/N/DK). If 2e is YES or DO NOT KNOW, go to line 24. If 2e is NO go to line 19.	
19	2f. Are the conditions within Florida deteriorating? (Y/N/DK). If 2f is YES or DO NOT KNOW, go to line 23. If 2f is NO, go to line 20.	
20	2g. Can the breeding population rescue the Florida population should it decline? (Y/N/DK). If 2g is YES, go to line 21. If 2g is NO or DO NOT KNOW, go to line 22.	
21	If 2g is YES - Downgrade from initial finding (less imperiled)	
22	If 2g is NO or DO NOT KNOW - No change from initial finding	
23	If 2f is YES or DO NOT KNOW - No change from initial finding	
24	If 2e is YES or DO NOT KNOW - No change from initial finding	
25		
26	Final finding	No change

Appendix 1. Calculation of generation time presented at the BSR group meeting

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. We estimate generation length for the Lower Keys population of the striped mud turtle as follows. Age to maturity is estimated at a mean of 5 years based on Iverson (1979) and Wilson et al. (2006). Longevity is estimated at ca. 40 years maximum based on data from Wilson et al. (2006) and the closely related *K. subrubrum* (Meshaka and Gibbons 2006). There is no reason to distinguish sexes. 30 years may be a reasonable life expectancy for most mature individuals. Generation length is estimated as (5 + 30)/2 = 17.5 years.

Appendix 2. Biological Review Group Members Biographies

Chris Lechowicz is the Interim Director of the Wildlife Habitat Management Program and staff herpetologist at the Sanibel-Captiva Conservation Foundation where he has worked since 2002. He has a B.S. in Zoology and Computer Science from Southern Illinois University at Carbondale and will complete his M.S. in Environmental Science from Florida Gulf Coast University in 2010. Chris's focus is on riverine turtles with a specialty on the Genus *Graptemys.* Chris is a member of the IUCN/SCC Tortoise and Freshwater Turtle Specialists Group as well as a board member of the Florida Turtle Conservation Trust.

Dr. Peter A. Meylan received his Ph.D. from the University of Florida. He is a Professor of Biology at Eckerd College in Saint Petersburg, FL. His research interests include the evolutionary history, ecology, and conservation biology of amphibians and reptiles, especially turtles. Current research includes 2 sea turtle projects: an investigation of the ecology and migrations of sea turtles of Bocas del Toro Province, Panama (funded by the Wildlife Conservation Society) and the Bermuda Turtle Project, which is a cooperative project with the Bermuda Aquarium and the Caribbean Conservation Corporation (as well as continuing to work with Florida freshwater turtles with the Eckerd Herpetology Club on the Rainbow River). He has many scientific articles on turtles and is the editor of a book on the biology and conservation of Florida turtles.

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 more than 90 publications on amphibians and reptiles.

Travis Thomas is a graduate student in Wildlife Ecology and Conservation at the University of Florida. His research primarily focuses on the ecology and management of macrofauna in riparian systems. He received his Bachelor's Degree in Natural Resources Conservation from the University of Florida in May 2009. He has worked for 7 years on *M. temminckii* and most recently worked on gopher tortoises for FWC under Joan Berish. He worked for 3 years in the Herpetology Dept. under Dr. Kenneth Krysko at the Florida Museum of Natural History. He has spent time as a volunteer on numerous projects in Kenya, Africa, under the supervision of Leigh Ecclestone and the Kenyan Wildlife Service. He has published several notes on the ecology and distribution of reptiles and is currently a co-author on a study of the ecology of *M. temminckii* in O'Leno State Park as well as the primary author on a study of the morphology of *M. temminckii*.

William M. Turner received his B.S. from Erskine College and M.S. in Biology from the University of South Alabama. From 2003 to 2007, he was the Herpetological Coordinator for the Wyoming Game and Fish Department. In Wyoming, he conducted statewide surveys for amphibians and reptiles, focusing on emerging amphibian diseases and the impacts of resource development on native reptiles. Since 2007, he has been the Herp. Taxa Coordinator for FWC in the Division of Habitat and Species

Conservation. He has conducted research on native amphibians and reptiles in Florida, Alabama and Wyoming that resulted in several published papers and reports.

Appendix 3. Summary of letters and emails received during the solicitation of information from the public period of September 17, 2010 through November 1, 2010.

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

APPENDIX 4. **Information and comments received from independent reviewers.**

To be added after peer review.