Mangrove Rivulus Biological Status Review Report

March 31, 2011

FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION
620 South Meridian Street
Tallahassee, Florida 32399-1600

Biological Status Review
for the
Mangrove rivulus
(*Kryptolebias marmoratus*)
March 31, 2011

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 November 8, 2010 that had not undergone a status review in the past decade. Public information on the status of the mangrove rivulus, *Kryptolebias marmoratus*, was sought from September 17 to November 1, 2010. The members of the mangrove rivulus Biological Review Group (BRG) met on November 18 and 19, 2010. Group members were Scott Taylor (Brevard County), Carole McIvor (US Geological Survey), and Ed Matheson (FWC lead) (Appendix 1). In accordance with rule 68A-27.0012, Florida Administrative Code (F.A.C.), the BRG was charged with evaluating the biological status of the mangrove rivulus using criteria included in definitions in 68A-27.001, F.A.C., and following the 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/imperiled/listing-action-petitions/ to view the listing process rule and the criteria found in the definitions.

In late 2010, staff developed the initial draft of this report which included BRG findings and a preliminary listing recommendation from staff. The draft was sent out for peer review and the reviewers' input has been incorporated to create this final report. The draft report, peer reviews, and information received from the public are available as supplemental materials at http://myfwc.com/wildlifehabitats/imperiled/biological-status/.

The BRG concluded from the biological assessment that the mangrove rivulus did not meet listing criteria. Based on literature review and the BRG findings, FWC staff recommends the mangrove rivulus not be listed as a Threatened species and that it be removed from the Species of Special Concern list.

This work was supported by a Conserve Wildlife Tag grant from the Wildlife Foundation of Florida. FWC staff gratefully acknowledges the assistance of the biological review group members and peer reviewers. Staff would also like to thank Perran Ross for his assistance in the status review process.

BIOLOGICAL INFORMATION

Taxonomic Classification – This biological status report is for the mangrove rivulus in Florida. Most recent authors use the scientific name *Kryptolebias marmoratus* for this species, but it appears under the name *Rivulus marmoratus* in various literature sources.

Life History References – Fowler (1928), Harrington and Rivas (1958), Harrington (1961), Harrington (1967), Hastings (1969), Harrington (1971), Huehner et al. (1985), Vrijenhoek (1985), Briggs and Brown (1986), Ritchie and Davis (1986), Abel et al (1987), Grizzle and Thiyagarajah (1987), Taylor (1988), Davis et al. (1990), Taylor (1990), Gilbert (1992), Taylor (1992), Turner et al. (1992a and 1992b), Taylor (1993), Davis et al. (1995), Lin and Dunson (1995), Taylor et al. (1995), Cole and Noakes (1997), Sola et al. (1997), Dunson and Dunson (1999), Lin and Dunson (1999), Taylor (1999), Weibel et al. (1999), Sakakura and Noakes (2000), Taylor (2001), Taylor et al. (2001), Taylor (2003), Grageda et al. (2005), Miller (2005), Mackiewicz et al. (2006a and 2006b), Nordlie (2006), Taylor et al. (2008), McIvor and Silverman (2010).

Geographic Range and Distribution – The mangrove rivulus is found from southeastern Brazil through the Antilles and Central America to Florida (Taylor 1999). It was first reported from Florida in 1927 as *Rivulus cylindraceus* (Fowler 1928) but was not collected again until the 1950s (Harrington and Rivas 1958, Taylor 1999). The earliest Florida records were from the Keys and the east coast, with the known range in this region being from the Keys to Volusia County (Taylor 1999). West coast specimens were not collected until 1967 (Hastings 1969), and the first specimens from the northern extent of its known range on the west coast, Tampa Bay, were not collected until 1985/1986 (Briggs and Brown 1986).

Population Status and Trend – The status of the mangrove rivulus in Florida is difficult to determine due to cryptic habits that make this species invulnerable to most standard fish-collecting gear (Taylor et al. 2008). Between 1928 and 1999, an estimated 2,188 specimens were collected in Florida (Taylor 1999), but recent studies employing new types of sampling gear have collected large numbers over small geographic areas. For example, McIvor and Silverman (2010) collected 450 specimens with modified bottomless lift nets from riverine mangroves in southwest Florida from 2001 to 2007; the next most abundant fish taxon collected in this study was represented by only 37 individuals. Similarly, recent studies have indicated that this species is much more common in the Tampa Bay area than previously thought (McIvor, unpublished data).

Quantitative Analyses – To the best of our knowledge, no one has conducted any analyses (population viability analyses or other quantitative analyses) designed to calculate a probability of extinction for the mangrove rivulus.

BIOLOGICAL STATUS ASSESSMENT

Threats – Threats to the mangrove rivulus in Florida were summarized by Taylor (1999). The primary threat is habitat destruction, with the distribution of this species being closely tied to the presence of mangroves (Taylor 1999, Taylor et al. 2008). Taylor (1999) mentions an estimated overall loss of mangrove habitat of 23% through the 1980s but indicates that this figure is uncertain and that habitat loss has continued since that time. Also, climate change, particularly sea level rise may have deleterious effects on mangrove habitat. Another threat of unknown extent is the use of pesticides in coastal habitats to control mosquitoes (Taylor 1999).

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

LISTING RECOMMENDATION

Based on the mangrove rivulus BRG findings, a thorough literature review, and information received during the independent review, fish taxa staff in joint consultation recommend the mangrove rivulus not be listed as a Threatened species and that it be removed from the Species of Special Concern list.

SUMMARY OF THE INDEPENDENT REVIEW

Comments were received from four reviewers, Dr. William P. Davis (U.S. Environmental Protection Agency), Dr. David L. Bechler (Valdosta State University), Dr. Sven Kupschus (Lowestoft Laboratory, England), Dr. Ryan Earley (California State University, Fresno). Editorial changes recommended by the reviewers were incorporated into this report when appropriate. Three of the four reviewers agreed with the overall conclusions of the BRG. The fourth reviewer disagreed with the overall conclusion that the mangrove rivulus does not meet the criteria for continued listing by the State of Florida because of the general lack of data on populations of this species in Florida. The BRG recognizes the paucity of data but still believes that this species does not meet the criteria. Two of the members of the BRG have conducted extensive field and laboratory research on the mangrove rivulus. They believe that sufficient data are available to support the overall conclusion with the addition of cautionary notes regarding factors such as future habitat loss. Several of the reviewers cautioned that the change in the status of the mangrove rivulus in Florida should not preclude continued research and monitoring of its populations in the state, especially in the event of future changes in factors such as climate, mangrove distribution and management, and harvest levels and regulations. One reviewer was concerned that the BRG did not clearly explain the reason for changing the status of this species; this change is based both on new criteria and new data, especially for Gulf coast populations, as outlined in this document. One reviewer indicated that statements about overall population size and local abundance are weakened by the lack of appropriate sampling efforts over the known range of this species in Florida; the BRG recognizes and agrees with this assessment, but we do not believe it negates the overall findings of this review. The full text of peer reviews is available at MyFWC.com.

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Biological Status Review Information
Findings

Species/taxon: *Kryptolebias marmoratus* Mangrove rivulus
Date: 11/18/10
Assessors: Scott Taylor, Carole McIvor, Ed Matheson

Generation length: Use 10 years, reproduction>1yr, max life expectancy (captive) = 8 yrs

Criterion/Listing Measure	Data/Information	Data Type*	Sub-Criterion Met?	References
*Data Types - observed (O), estimated (E), inferred (I), suspected (S), or projected (P). Sub-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]	Concern about habitat loss and quality decline but not possible to make quantitative estimate. No basis for estimation of habitat (mangrove) loss in 10 yrs. Population estimates from Shark river 2001-2007- no trend McIvor references. Field surveys along Florida east coast indicate possible decline but not quantified (Taylor pers. comm.)		NO	McIvor et al. 2009, McIvor et al. 2008
(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]	see above		NO	
(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]	Mangrove habitat increasing (Tampa Bay) but habitat quality (east coast land crabs burrows) may be declining.		NO	
(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]	see above		NO	
[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	238131ha=2381 km^2 total mangrove habitat	O	YES	FWC Comp. Wildlife Conservation Strategy
(b)2. Area of occupancy < 2,000 km^2 (772 mi^2)	na			

AND at least 2 of the following:				
a. Severely fragmented or exist in ≤ 10 locations	East coast populations likely disjunct from south and west and some discontinuity from past coastal development but not fragmented sensu criteria. Distribution from Brazil to Fl and Caribbean Islands suggests highly mobile most probably as eggs (or perhaps juveniles or adults) adhering to debris.	S/I	NO	Taylor et al. 2008
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	Decline projected in habitat quality on east coast due to coastal development and associated changed relationships mangrove-grass and land crab reductions (rivulus use crab burrows) and sea level rise in long term. Additional concern is excessive collection for science and aquarium trade with associated habitat destruction and genetic mixing of different stocks. Continued restriction of uncontrolled collection is recommended e.g. add species to Marine Life collection fisheries rule (Mgt. Plan)	S/I	YES	Taylor pers. comm, Raabe et al. unpub., McIvor pers. comm.
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	field studies unable to confirm		NO	
(C) Population Size and Trend				
Population size estimate to number fewer than 10,000 mature individuals AND EITHER	Numbers likely 100,000s +. Density estimates at single location 40 km (Shark River) 6400-93600 total = approx 3-50,000 adults from size distribution. Occur at similar density in numerous other locations throughout range.	E/I	NO	McIvor pers comm. unpublished results
(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			NO	
(c)2. A continuing decline, observed, projected, or inferred in numbers of mature individuals AND at least one of the following:	see Crit Bb above		YES	
a. Population structure in the form of EITHER			NO	
(i) No subpopulation estimated to contain more than 1000 mature individuals; OR				
(ii) All mature individuals are in one subpopulation			NO	
b. Extreme fluctuations in number of mature individuals			NO	
(D) Population Very Small or Restricted, EITHER				

(d)1. Population estimated to number fewer than 1,000 mature individuals; OR	See above		NO	
(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	see above		NO	
(E) Quantitative Analyses				
e1. Showing the probability of extinction in the wild is at least 10% within 100 years			NO	

Initial Finding (Meets at least one of the criteria/sub-criteria OR Does not meet any of the criteria/sub-criteria)	Reason (which criteria/sub-criteria are met)
Does not meet any criteria	
Is species/taxon endemic to Florida? (Y/N)	NO

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/sub-criteria OR Does not meet any of the criteria/sub-criteria)	Reason (which criteria/sub-criteria are met)
Does not meet criteria	

1	Biological Status Review Information Regional Assessment	Species/taxon: Kryptolebias marmoratus
2		Date: 11/18/10
3		Assessors: Scott Taylor, Carole McIvor, Ed Matheson
4		
5		
6		
7		
8	Initial finding	Supporting Information
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.	NO
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.	NO- little genetic diff with central America indicates some exchange but likely not significant
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 Florida 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: Brief biographies of the Mangrove rivulus Biological Review Group members

Dr. Eddie Matheson, Jr. was born in Knoxville, Tennessee in 1952 and has spent most of his professional career at the institution currently known as the Florida Fish and Wildlife Research Institute (Fish and Wildlife Conservation Commission). He received his B.S. and M.A. from the College of William & Mary in Virginia and his PhD from Texas A&M University. After conducting postdoctoral research at Harbor Branch Oceanographic Institution in Florida and Rutgers University in New Jersey, he accepted a position at the Florida Fish and Wildlife Research Institute and has worked at that institute since 1987. His research focus has been the ecology and systematics of fishes, and he has published peer-reviewed papers and authored numerous reports on fishes in habitats ranging from freshwater streams to the deep sea. Current research includes seagrass-associated species, species of tidal rivers, and species of the West Florida Continental Shelf.

Dr. Carole McIvor holds BA and MS degrees in Biology and a PhD in Environmental Sciences, the latter from the University of Virginia. She is a research fisheries biologist and wetlands ecologist with the US Geological Survey in St Petersburg, FL. Carole's specialty is the habitat and trophic ecology of wetlands-associated fishes. Her most recent work has been on mangrove environments in Everglades National Park, Tampa Bay and the offshore cays on the Belize Barrier Reef. She has co-authored publications with colleagues and students in well-respected scientific journals including Ecology, Marine Ecology - Progress Series, Canadian Journal of Fisheries and Aquatic Sciences, Wetlands, Bulletin of Marine Science and Wetlands Ecology and Management. She is presently working on identification of critical nursery habitats of red drum and common snook in Tampa Bay using microchemical analysis of fish otoliths.

Dr. D. Scott Taylor received his PhD in marine biology from Florida Institute of Technology and is currently an adjunct professor at Brevard Community College. Scott has been Central Region Land Manager, Brevard County Environmentally Endangered Lands Program, since 2002. This position directly benefits from his extensive travels and 14 years with Brevard Mosquito Control as a biologist. Dr. Taylor is one of only two scientists in Florida actively studying and publishing on the biology and habitats of the mangrove rivulus.

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

No information about this species was received during the public information request period.