Supplemental Information for the Mangrove Rivulus

Biological Status Review Report

The following pages contain peer reviews received from selected peer reviewers 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. David Bechler

From: David L. Bechler
To: Imperiled
Subject: Status of Kryptolebias marmoratus--Reviewer Commnts
Date: Thursday, February 03, 2011 3:12:52 PM
Attachments: Biological Status Review Information.pdf
Biological Status Review Information.docx

Please see attached Word and PDF documents concerning the review of the status of Kryptolebias marmoratus in Florida.

Thanks for the opportunity to make this review. Please advise me if any other information is needed on this review.

David L. Bechler
Dept of Biology
Valdosta State University
Valdosta, GA 31698

Biological Status Review Information on *Kryptolebias marmoratus*
Outside Reviewer's Comments

David L. Bechler
Department of Biology
Valdosta State University
Valdosta, GA 31698

(A) Population Size Reduction

(a)1. Since the status of potential *K marmoratus* subpopulations along the entire known range (Volusia Co. on the east coast to the Florida Keys to the more recently discovered Tampa Bay populations) of Florida has never been assessed, a **Criterion of "No" is appropriate** as no trends can be ascertained.

(a)2. Based on comments in (a)1, **Criterion of "No" is appropriate**.

(a)3. Concerns for habitat loss and alterations of coastal wetlands (Stone and Penland, 1992; Harwell, 1998; Davis and Barnard, 2000; Rudnick, 2005) and associated microhabitats such as mangroves (Strong and Bancroft, 1994, Cross; 2001) and land crab burrows (Taylor, 1992; Taylor, et al. 1995) are realistic, and will directly impact the size and existence of subpopulations in areas such as the Florida Keys and the east and west coastal areas north of the Everglades. However, as noted in section (a)1, there are not data sets to base future projections on rates of habitat loss that will impact subpopulations *of K marmoratus*. A compounding point is the interplay of thermo tolerance and habitat which is not fully understood (Taylor, 1993). Therefore a **Criterion of "No" is appropriate**.

(a)4. **Criterion of "No" is appropriate**.

(B) Geographic Range

(b)1. a. The statement that discontinuity of subpopulations is likely cannot be ascertained is reasonable given the fragmentation of habitats via human development. However, subsequent a statement concerning distribution of eggs from Brazil to Florida seems contradictory. Also, no comment on the potential for distribution via rafting by flotsam is mentioned. Until the true impact of rafting on egg, juvenile and adult stages is determined, a **Criterion of "No" is appropriate**.

(b)1. b. Excessive collecting of localized populations in limited accessible habitat is definitely possible, but McIvor and Silverman (2010) indicate populations in the Shark River area are reasonably abundant and also difficult to collect using standard methods. The discovery of log-packing (Taylor, et al., 2008) also indicates that the cryptic nature of the species in combination with it use of other microhabitats may result in underestimations of subpopulation sizes. This would imply that "additional concern" of over-collecting by aquarium trade may not be warranted except for subpopulations of very limited size. More extensive data needs to be collected across the entire Florida range to fully access this. Given the limited sample sizes

collected by most scientists up until now and the restrictions set forth by the state of Florida for scientific collecting permits, concern on over collecting by scientists does not seem warranted unless it occurs in small subpopulations. Given the continued loss of habitat and the potential concomitant loss of subpopulations via commercial, industrial and housing development along the more southerly east and west coasts of Florida, it is reasonable to assume or project a continued reduction of subpopulations. Therefore, a **Criterion of "Yes" is accurate**.

(b)1. c. Lacking detailed information on the distribution, number of subpopulations and size of subpopulations, a **Criterion of "No" is appropriate**.

(C) Population Size and Trend Extrapolations of data on sample sizes collected via bottomless fence nets (McIvor and Silverman, 2010) to the larger area of Shark River in which suitable habitat exists as well as other areas of the Everglades, indicates that sample sizes approaching or greater than 100.000+ individuals is reasonable. Such sample sizes also indicate that aquarium and scientific collecting if not carried out on small limited subpopulations should not have significant impacts on K. marmoratus in Florida. **Criterion of "No" is appropriate**.

(c)1. **Criterion of "No" is appropriate**.

(c)2. Two factors predict that the number of mature individuals will decline over the next 10 years as well as for longer time periods. Factor one, while I have not found any literature that specifically examines rising sea levels and the direct impact they will have on specific coastal Florida wetlands, it is reasonable to assume that at least in some coastal areas rising sea levels (Reed, 1995) will result in reduced habitats resulting from erosion of coastlines or alteration of habitats. Factor two, the continuing coast development will produce consequences similar to rising sea levels, but over a much shorter time frame. As such a **Criterion of "Yes" is accurate**.

(c)2.a(i). **Criterion of "No" is appropriate**.

(c)2.a(ii). **Criterion of "No" is appropriate**.

(D) Population Very Small or Restricted.

(D)1. **Criterion of "No" is appropriate**.

(D)2. **Criterion of "No" is appropriate**.

(E) Quantitative Analyses. Given the lack of population and subpopulation data discussed above, the rate of population decline cannot be determined at present. Therefore, a **Criterion of "No" is appropriate**.

Is the species/taxon endemic to Florida. As evidenced by Harrington and Rivas (1958), K. marmoratus is native to Florida. Therefore, a **Criterion of "No" is appropriate**.

References Sited by the Reviewer.

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Peer review #2 from Ryan Earley

From: Ryan Earley
To: Imperiled
Subject: Review for mangrove rivulus BSR Report
Date: Sunday, February 06, 2011 8:13:29 AM
Attachments: Review_FWC.pdf
ATT00001.htm

Dear Dr. Haubold,

Please find my review of the mangrove rivulus Biological Status Review attached as a PDF file. My apologies for getting this to you at the last possible moment. Thank you for the opportunity to participate in the review process.

Best regards,

Ryan Earley

Review for Florida Fish and Wildlife Conservation Commission
Biological Status Review (BSR) for Florida's Threatened and Species of Special Concern List
Species under review: mangrove rivulus; *Kryptolebias (formerly Rivulus) marmoratus*

1. Completeness and accuracy of the biological information and data analyses in the BSR

Members of the mangrove rivulus BRG have compiled a complete list of published resources on this species (in an Excel file at http://share3.myfwc.com/BioStat/default.aspx). The BRG reference the relevant life history, range, and population status literature in the biological status review.

In the *Geographic Range and Distribution* section, the authors refer to the "northern extent of its range on the west coast, Tampa Bay". Has sampling been conducted even further north with no evidence of extant mangrove rivulus populations? If so, the statement quoted above is warranted; if not, the BRG might consider changing this to the "currently known northern extent of its range" or "northern extent of its range based on surveys conducted to the present date; additional sampling north of Tampa Bay is required."

In the *Population Status and Trend* section:
• Change "due cryptic habits" to "due to cryptic habits"
• This reviewer is a bit concerned about how the *Population Status and Trend* section is constructed. The advent and use of new sampling gear has indeed allowed researchers to better evaluate population status, and has resulted in a greater collection rate for mangrove rivulus than had previously been documented in the field (e.g., from 1928-1999). But these sampling techniques have been used in few locations throughout the mangrove rivulus' range and this reviewer is concerned about the validity of extrapolating, for instance, the Shark River findings (McIvor & Silverman 2010) to other populations, especially those with different habitat characteristics and those in unprotected non-National Park lands with greater anthropogenic influence. The BRG also refers to collection of 450 specimens using modified bottomless lift nets from 2001-2007; these specimens were collected from 189 net deployments, which amounts to 2.38 animals per net haul. These numbers, in the reviewer's estimation, are promising but not extraordinary when examining the data on a 'per haul' basis. Furthermore, although the mangrove rivulus accounted for a significant percentage of the biomass captured in the modified bottomless lift nets, habitat type should be considered explicitly before drawing general conclusions about relative species abundances (e.g., perhaps the nets were deployed in perfect mangrove rivulus habitat but less suitable habitat for many other species such as rainwater killifish [N=15 caught] or marsh killifish [N=4 caught] that may have greater overall abundances in the mangroves). The general 'feeling' from this section is that the mangrove rivulus is on the upswing from a population standpoint; this may very well be the case but additional field surveys across the Florida range, especially in unprotected mangrove forests, should be required to more finely resolve population status and habitat suitability (e.g., potential for a fragmented distribution, esp. on the west coast of FL).

• The BRG refers to recent studies indicating that the mangrove rivulus is more common in the Tampa Bay area than previously thought, citing unpublished data from one of the BRG

members. What was the expected population size, 'catch per trap/person hour', or other estimate of mangrove rivulus numbers? How was the expected yield/population size determined? What techniques (e.g., analytical, statistical, observational) were used to conclude that the observed numbers of this species in the Tampa Bay area was greater than expected? Based on the National Marine Fisheries Service brochure for the mangrove rivulus (see Figure 2 in that brochure), west coast populations would represent a range extension thus any mangrove rivulus collected would likely be 'greater than expected' (at least historically). However, given that very little is known about these west coast populations relative to those in eastern Florida and the Keys, this reviewer considers it of utmost importance to have quantitative data on numbers, population continuity, long-term population viability, and habitat (including information on quality, fragmentation, and degradation) before drawing conclusions about population status.

In the *Biological Status Assessment (Threats)* section:

• This reviewer recommends elaborating on what constitutes "loss of mangrove habitat". For instance, are impoundments, which can isolate populations and prevent gene flow (even for a species that propagates via self-fertilization with occasional out-crossing), still considered proper/viable mangrove habitat? Given some evidence that the mangrove rivulus specializes on certain niches within mangrove habitat (e.g., crab burrows on East Florida coast and Keys; known for West Coast??), is it possible that overall estimates of mangrove degradation underestimate (or less likely, overestimate) the loss of these particular niches?

In the *Listing Recommendation* section:

The BRG report: "Based on the mangrove rivulus BRG findings, a thorough literature review, and information received from the public….". According to Appendix 2, no information about the mangrove rivulus was received from the public.

Notes on the Biological Status Review Information – Findings table:

(A.a.3) – What quantitative data are available to support the increase in mangrove habitat in Tampa Bay? This is a region-specific note and this reviewer suggests also noting data (or lack thereof) for other regions in the mangrove rivulus' range.

(C) – How were these densities calculated? And, what evidence is available to suggest that similar densities occur at "numerous other locations throughout [the] range"?

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

The BRG recommend removal of the mangrove rivulus from the FWC list of imperiled species because they failed to meet any criteria for this designation. They also recommend (B.b) "continued restriction of uncontrolled collection…(e.g, add species to Marine Life collection fisheries rule [Mgt. Plan])." Based on the Biological Status Review, this reviewer finds that the BRG is justified in their assessment of Criteria *(A) Population Size Reduction, (C) Population Size and Trend, (D) population Very Small or Restricted,* and *(E) Quantitative Analysis.* This

reviewer is concerned about the final evaluation of Criterion *(B) Geographic Range*. This reviewer's understanding is that, to be maintained on the FWC list of imperiled species, one of the five above-listed criteria must be met and, for Criterion (B), the following sub-criteria must be met:

(b.1) – Extent of occurrence < 20,000 km2 (7,722 mi2) **OR** (b.2) – Area of occupancy < 2,000 km2 (772 mi2) **AND** two of the following: a) Severe fragmentation or exist in < 10 locations; b) Continuing decline, observed, inferred or projected in *(i) – (v)*; c) Extreme fluctuations in *(i)-(iv).*

The BRG identifies the mangrove rivulus as meeting (b.1) **and** [b; *Continuing decline, observed, inferred or projected in (i)-(v)*]. The BRG also refers to the lack of available data for [c; *Extreme fluctuations in (i)-(iv)*].

Given that the mangrove rivulus is currently on the FWC list of imperiled species, this reviewer finds it somewhat troubling that the BRG considers the lack of available data to be a justifiable reason for removing the species. This is particularly true given that no significant surveys, to the reviewer's knowledge, have been conducted to evaluate [c; *Extreme fluctuations in (i)-(iv)*]. For instance, surveys before and after freeze events such as those that have struck Florida in the past couple of years might provide insights into the susceptibility of mangrove rivulus populations to extreme fluctuations at the hands of climate.

The only evident 'improvement' to the mangrove rivulus' status since being designated is the potential for abundances to be greater than expected but this assessment is based on few studies (one recent;
McIvor & Silverman 2010) conducted in specific regions and on protected lands. The BRG may have additional data to support their conclusions but, based on what was written in the Biological Status Review (+ accompanying table), this reviewer finds the recommendation for removal from the FWC list to be premature, and the species to be severely 'data-deficient'.

There appears to be an essential need to gather more information on mangrove rivulus' distribution (esp. on west coast of FL), population fragmentation/size, habitat type (throughout the range), genetics, and life history/behavioral characteristics, and the extent of habitat degradation.

Peer review #3 from Sven Kupschus

From: Sven Kupschus (Cefas)
To: Imperiled
Cc: Matheson, Eddie
Subject: RE: Mangrove rivulus Draft BSR Report
Date: Friday, December 31, 2010 5:55:35 AM
Attachments: BSRmangroverivulusReviewSK.docx

Dear Elsa,

Please find attached my review of the mangrove rivulus BSR. I am not an expert on species listings, nor on mangrove rivulus, although I have extensive knowledge on mangrove habitats in Florida and the issues surrounding their conservation. In addition I have on occasions come across this species and have been fascinated by its quirky life history so that my comments should be viewed in that context when compared to the panels assessment, which consists of members far more familiar than I with this species.

Sven

Review of the 'Biological Status Review for the Mangrove rivulus *Kryptolebias marmoratus*.
Reviewd by Sven Kupschus: 31/12/2010

I have reviewed the document and found it scientifically sound in general. Due to the sparsity of quantitative information and the low spatial resolution of sampling it is not possible to determine specific trends in the population. However, the review group panel appears to consist of people with the necessary expertise and experience to much better judge the threat to this species in Florida than I am able to do. In general I can find no significant evidence to suggest the classifications with respect to the threat criteria listed in the summary table, nor the logical application of the 'IUCN Red List criteria' so conclude that the recommendation to delist the species proposed in the BSR is appropriate

There are however a number of issues that I feel could be better expressed or clarified in the document. These are as follows:

First and foremost the species was listed in 1997 as a 'species of greatest conservation need' in Florida, the major threats being identified as habitat alteration, development and mosquito control. To my knowledge little has changed since then in these threats, so that in the absence of any indication of an increasing population, one has to assume that the panel made it decision to delist on the basis of some new biological understanding the origin of which is not clear from the document provided.

The original listing was specific to the east coast and Keys area, where as this review is more general for the whole of Florida, has this shift in scale been a major contributor to the reclassification? In other words does the east coast population remain threatened (it is considered isolated from the west coast population in the document), and is it the stability in estimated population size of the west coast population that has caused the down grading of the threat criteria?

Under the heading THREATS loss of mangrove habitat is cited, but this seems to apply to general mangrove habitat and rivulus tend to be associated most closely with red mangroves. Certainly climatic conditions have had a significant impact on the distribution of mangroves, particularly increasing white mangrove habitat in the northern parts of Florida's east coast, but to what extent this benefits rivulus is questionable so that the use of general mangrove abundance trends should be viewed with some caution.

Ongoing habitat fractionation has in the past been cited as one of the reasons for listing this species, but under B2a (attached Table) the habitat is deemed not to be fractionated. This of course is dependent on the scale of observation and the distance over which propagules are able to re-colonize a site. It is not clear whether it is the new classification scheme, a better understanding of the biology of the species or an improvement in habitat conditions that lead to these conclusions.

The NOAA Species of Concern document also indicates the specific association of rivulus with the land crab genus *Cardisoma*. The new document although mentioning this association (under B2b in table) makes no reference in the threat section of this association. It is my understanding

that the continued non-commercial exploitation of this species as well as increasing development of roads and housing (general habitat loss as well as obstructing spawning migrations) in the coastal area continues to threaten and even decline number of land crabs so that one has to assume that this would lead to increasing habitat degradation for rivulus also. It may be that the relationship is now thought to be much less facultative than previously thought or only of local importance (but this is not brought out in the document), or it may be that symbiotic relationships play a much lesser role in the new classification system and this should be brought out in the decision to reclassify.

Lastly, it would be good to clarify that the species has been reclassified taxonomically from *Rivulus* to *Krytolebias* as much of the literature provided still refers to the old name as does the previous listing.

In conclusion I find the topic well researched given the extremely limited amount of available information and in general agree with the appropriateness of the classification provided. I stress though that in my view the delisting is not one based on the improvement of the condition of mangrove rivulus or a greatly improved understanding of the biology of the species and hence its susceptibility, but one of the application of a new classification system. The new scheme appears to be based more on specific quantitative indicators, which do not exist for this species, and is less precautionary than the previous classification system in the absence of such indicators.

Peer review #4 from William Davis

From: WILL DAVIS
To: Imperiled
Subject: Re: Deadline reminder for peer reviews of BSR reports
Date: Tuesday, February 15, 2011 10:10:30 AM
RE: Biological Status Review (BSR) for rivulus (Kryptolebias marmoratus, mangrove rivulus):

Dear Elsa,

I have read and thought about the conclusions of the Biological Status Review for mangrove rivulus (Kryptolebias marmoratus). I think that the conclusion to remove rivulus from a "species of concern" status is justified considering the revised criteria and the current state of knowledge of this species. It does concern me that this decision must not in any way be construed to decrease our concern and protection of mangrove habitats. As we have continued to learn more about the biology of rivulus we realize how well adapted it is to survive many ecological challenges. Simultaneously, we see how closely, if not critically, this species is tied to mangrove habitats. Therefore, as we may decide that the fish is not in immediate danger, I continue to believe its habitat is continually imperiled, especially in Florida. With respect to biological adaptations of mangrove rivulus, I suggest that another reference be added to the literature cited:

Ritchie, S.A. and W.P. Davis. 1986. Evidence for Embryonic Diapause in Rivulus marmoratus Poey 1880 (Cyprinodontidae). Fla Sci. 48(1):1-7.

This report includes original data supporting diapause or survival of embryos through drought periods in Florida. I do not believe similar data for rivulus are reported elsewhere in the scientific literature.

In conclusion, I applaud the thorough work of the review committee. I sincerely hope that removal from a 'species of concern' status will stimulate continued research and attention to mangrove rivulus, its biology and the protection of mangrove habitats upon which it depends.

Sincerely,

William P. Davis
Research Ecologist

Copy of the Mangrove rivulus BSR draft report that was sent out for peer review

Biological Status Review
for the
Mangrove rivulus
Kryptolebias marmoratus

EXECUTIVE SUMMARY

The Florida Fish and Wildlife Conservation Commission (FWC) directed staff to evaluate all species listed as Threatened or Species of Special Concern as of September 1, 2010. Public information on the status of the 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, Carole McIvor, and Ed Matheson. 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(3) 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://www.myfwc.com/WILDLIFEHABITATS/imperiledSpp_listingprocess.htm to view the listing process rule and the criteria found in the definitions.

The BRP concluded from the biological assessment that the mangrove rivulus did not meet regionally-applied IUCN criteria for listing under the new FWC Listing Protocols, based on the best scientific information available at this time.

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

BIOLOGICAL INFORMATION

Taxonomic Classification – This biological status report is for the mangrove rivulus in Florida.

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), 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 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 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).

Statewide Population Assessment - None available

LISTING RECOMMENDATION

Based on the mangrove rivulus BRG findings, a thorough literature review, and information received from the public, fish taxa staff in joint consultation recommend removing the mangrove rivulus from the FWC list of imperiled species.

SUMMARY OF THE INDEPENDENT REVIEW – *this will be completed after the peer review*

LITERATURE CITED

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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*	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]	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 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 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 resullts
(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 OR Does not meet any of the criteria)	Reason (which 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 OR Does not meet any of the criteria)	Reason (which 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: Biological Review Group Members' Biographies

Dr. Eddie Matheson (FWC/FWRI, Lead-mangrove rivulus)
Richard E. 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.
Eddie.matheson@myFWC.com

Dr. Carole McIvor (USGS)
Carole C. 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.
carole_mcivor@usgs.gov

Dr. Scott Taylor (Brevard County EEL Program)
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. scott.taylor@brevardparks.com

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.

APPENDIX 3. **Information and comments received from independent reviewers.**

To be added later.