Supplemental Information for the Sims Sink/Santa Fe Cave

Crayfish 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. Keith Crandall

Evaluation of the Sim's Sink or Santa Fe Cave crayfish – *Procambarus erythrops*

1) Completeness and accuracy of the biological information and data analysis

The evaluation of the Sim's Sink Crayfish is thorough and has consulted all the published data I am aware of on this crayfish. The conclusion is a listing of Threatened which seems justified by the data and methodology. The IUCN listing is Endangered which is consistent with the listing proposed here due to the restricted geographic range. There are well documented threats to this species that coupled with the restricted range justify the listing as Threatened. The BSR clearly documents extirpated populations and extremely limited geographic range.

2) Reasonableness and justifiability of assumptions, interpretations of data, and conclusions

The assumptions of the assessment are reasonable and the interpretations of the data appropriate and therefore the conclusion of Threatened is also a well-justified conclusion. The species has a small geographic range, small population size, and has clear threats to the limited habitat. More information on the population structure and gene flow across karst systems would help in understanding the population size and threats of this species (e.g., Buhay and Crandall, 2005). Nevertheless, the proposed status of Threatened is justified by the available data. In the BSR Information Findings document, under data for population size reduction, there is listed "no data supporting xx% decline". Note that there is no data supporting that the population is stable either. This suggests that the conclusion is we assume populations are stable when we have no data. This is a dangerous approach to conservation biology and, I think, ill conceived. You should make conclusions based on what data you have, not on data you do not have. In this case, the data clearly indicate that the species is threatened.

Buhay, J. E., and K. A. Crandall. 2005. Subterranean phylogeography of freshwater crayfishes shows extensive gene flow and surprisingly large population sizes. Molecular Ecology 14:4259-4273.

Peer review #2 from Dr. Dale Jackson

From: DaleJackson [mailto:djackson@fnai.org]
Sent: Wednesday, January 26, 2011 4:32 PM
To: Cook, David
Subject: P. pictus review plus replacement erythrops review

Dave, I noticed that I had not included my name on the erythrops comments I sent yesterday, so

please substitute this one, which otherwise is unchanged.
Thanks for the other replies, which I'll dig into next week and use to update our database. I'll be back at FNAI on Monday if you need to reach me. Dale

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January 25, 2011

Procambarus erythrops Final Draft BSR review
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In general, I concur with the conclusions and have no additional data to offer. I provide a few comments below.

Common name: Following the FCREPA second edition (1994) and based on the species' occurrence at several sites besides Sims Sink, FNAI adopted the common name of Santa Fe Cave Crayfish, which would seem appropriate for FWC to use as well. Perhaps in the taxonomic classification section you could also say that "The species has also been denoted as the Sims Sink Cave Crayfish and the Red-Eyed Cave Crayfish." You should use the same case (upper or lower) for both "cave" and "crayfish," as the former is not referring to a specific cave. I do not believe that Sims has an apostrophe (not in FCREPA).

The FNAI database identifies only 5 element occurrences as well and ranks only two (Sims Sink, Azure Blue) of these highly, though data are not recent. Information is drawn from the same Franz references you cite as well as unpublished data he provided earlier. All 5 sites are in Suwannee County and within ca. 7 km of each other (which would be valuable to state). The draft BSR cites Columbia County as well, however. What is the source (Tom Morris?)? Any Suwannee County site would increase the total sites to at least 6 (as stated in the table), which is not clear in the text; perhaps add "Cave diver [karst specialist?] Tom Morris (give affiliation) more recently identified a sixth location in southern Columbia County" or something to that effect. FNAI (attention Dale Jackson) would welcome any such reports from FWC (Tom Morris has generously shared data with us multiple times, though not about this species; I'll drop him an e-mail as well). NatureServe data are drawn from FNAI, so please also cite FNAI as a source where you cite NatureServe.

Florida Resources and Environmental Analysis Center

Institute of Science and Public Affairs

Regarding the potentially extirpated population, how thorough are the data? Better to say "may have been" rather than "has apparently been" unless there have been comprehensive surveys.

The table states that no subpopulation has >1000 individuals, but evidence for this is not adequately cited in the text. Can you add something persuasive in Pop. Status & Trend? Why do you think this? Something like you note in Dd1 would help.

Copy of the Sims Sink/Santa Fe Cave Crayfish BSR draft report that was sent out for peer review

Biological Status Review for the Sim's Sink or Santa Fe Cave Crayfish (*Procambarus erythrops*)

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 Sim's Sink or Santa Fe Cave crayfish (*Procambarus erythrops*) was sought from September 17 to November 1, 2010. The members of the biological review group (BRG) met on November 18, 2010. Group members were David Cook (FWC lead), Paul Moler (retired FWC biologist, serving as an independent consultant), and Richard Franz (retired University of Florida/Florida Museum of Natural History biologist, serving as an independent consultant). In accordance with rule 68A-27.0012 Florida Administrative Code (F.A.C.), the BRG was charged with evaluating the biological status of the Sim's Sink or Santa Fe crayfish 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 BRG concluded that this species met three criteria: Criterion B (geographic range), Criterion C (population size and trend), and Criterion D (population very small or restricted). Staff recommends that the Sim's Sink or Santa Fe Cave crayfish, *Procambarus erythrops*, be included on the State-designated Threatened list because it meets criteria for listing as described in 68A-27.001(3).

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

BIOLOGICAL INFORMATION

Life History References Franz 1982, Franz 1994, Streever 1996, FNAI 2001, NatureServe 2010

Taxonomic Classification The current scientific name for the Sim's Sink or Santa Fe Cave crayfish is *Procambarus* (*Ortmannicus*) *erythrops*, with no recognized subspecies (Relyea and Sutton 1975). It is a member of the *lucifugus* complex (Franz and Lee 1982).

Population Status and Trend This species is known historically from 5 sites, although it has apparently been extirpated at one site due to the dumping of garbage (Franz 1994, Franz et al. 1994). Only 2 sites contain significant populations. One is the type locality, Sim's Sink, which is owned and managed by The Nature Conservancy; the other site, Azure Blue Sink, may need protection (Franz 1994, NatureServe 2010).

Geographic Range and Distribution This species is endemic to Florida and is known only from sites in southern Suwannee and southwestern Columbia counties (Franz 1994, Franz et al. 1994, NatureServe 2010, Tom Morris pers. comm.).

Quantitative Analyses We are not aware of a population viability analysis that has been done for the Sim's Sink or Santa Fe Cave crayfish.

BIOLOGICAL STATUS ASSESSMENT

Threats Potential threats include changes in hydrology and detrital flow (Franz 1982, Franz 1994, NatureServe 2010), garbage dumping, and mining (FNAI 2001). A kill and post-kill recovery of a related cave crayfish, *P. pallidus*, was reported for a Suwannee County cave due to physicochemical changes associated with flushing of contaminants or Suwannee River water during a flood event (Walsh 2001).

Statewide Population Assessment The BRG concluded that this species met three criteria: Criterion B (geographic range), Criterion C (population size and trend), and Criterion D (population very small or restricted). This assessment is specifically written as B1+2ab(ii,iii,v); C2a(i); D2. Specific findings from the BRG, including justification and pertinent references, are included in the Biological Status Review Information Findings tables below.

LISTING RECOMMENDATION

Staff recommends that the Sim's Sink or Santa Fe Cave crayfish, *Procambarus erythrops*, be listed as a Threatened species because it meets criteria for listing as described in 68A-27.001(3) F.A.C.

Biological Status Review Information
Findings

Species/taxon: Sims Sink/Santa Fe Cave Crayfish (Procambarus erythrops)

Date: 11/18/10

Assessors: David Cook, Paul Moler, Richard Franz

Generation length: unknown, but est. average 15 yrs; 3 generations = 45 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]	No data supporting 50% decline		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]	No data supporting 30% decline		N	
(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]	If hydrology and water quality stay the same, projection of 30% decline not anticipated.	P	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]	No data supporting 30% decline		N	
[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	Southern Suwannee County, southwestern Columbia County; estimated EOO < 375 mi^2	E	Y	Franz 1994, Franz et al. 1994, FWC staff 2010, Tom Morris pers. comm.
(b)2. Area of occupancy < 2,000 km^2 (772 mi^2)	Southern Suwannee County, southwestern Columbia County; estimated EOO < 375 mi^2	E	Y	Franz 1994, Franz et al. 1994, FWC staff 2010, Tom Morris pers. comm.
AND at least 2 of the following:				

a. Severely fragmented or exist in ≤ 10 locations	6 known localities, some of which may be considered to be the same location; ≤ 6 locations	O	Y	Franz 1994, Franz et al. 1994, FWC staff 2010, Tom Morris pers. comm.
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 area of occupancy (ii), quality of habitat (iii), and number of individuals (v) based on ongoing mining activity	O, P	Y	FNAI 2001, P. Moler pers. obs.
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	O	N	R. Franz unpub. data
(C) Population Size and Trend				
Population size estimate to number fewer than 10,000 mature individuals AND EITHER	Population estimated to be substantially < 10,000	E	Y	Franz 1982; Streever 1996
(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 data supporting 10% decline		N	
(c)2. A continuing decline, observed, projected, or inferred in numbers of mature individuals AND at least one of the following:	Decline in number of individuals inferred based on continuing decline in area of occupancy and quality of habitat	I	Y	P. Moler and R. Franz pers. comm.
a. Population structure in the form of EITHER	No subpopulation estimated to contain more than 1000 mature individuals	E	Y	Franz 1982; Streever 1996
(i) No subpopulation estimated to contain more than 1000 mature individuals; OR				
(ii) All mature individuals are in one subpopulation	Not applicable		N	
b. Extreme fluctuations in number of mature individuals	No extreme fluctuations		N	
(D) Population Very Small or Restricted, EITHER				
(d)1. Population estimated to number fewer than 1,000 mature individuals; OR	Subpopulation at Sim's Sink estimated to be 500, mostly mature; rangewide population may be >1000	E	N	Franz 1982; Streever 1996
(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	6 known localities, some of which may be considered to be the same location due to potential hydrological connectedness; ≤ 6 locations; cave entrances are energy input zones especially susceptible to local threats	O, I	Y	Franz 1994, Franz et al. 1994, Tom Morris pers. comm.
(E) Quantitative Analyses				

e1. Showing the probability of extinction in the wild is at least 10% within 100 years	No probability of extinction model done		N	

Initial Finding (Meets at least one of the criteria OR Does not meet any of the criteria)	Reason (which criteria are met)
Meets at least one of the criteria	B1+2ab(ii,iii,v); C2a(i); D2
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)
Meets at least one of the criteria	B1+2ab(ii,iii,v); C2a(i); D2

SUMMARY OF THE INDEPENDENT REVIEW This will be completed after the peer review.

LITERATURE CITED

Florida Natural Areas Inventory. 2001. Santa Fe Cave crayfish, *Procambarus erythrops*. Field guide to the rare animals of Florida. Florida Natural Areas Inventory, Tallahassee, Florida.

Franz, R. 1982. Species of Special Concern: Red-eyed cave crayfish. Pp. 112-113 in Franz, R. (ed.). Rare and endangered biota of Florida. Volume Six. Invertebrates. University Presses of Florida.

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Franz, R., J. Bauer, and T. Morris. 1994. Review of biologically significant caves and their faunas in Florida and South Georgia. Brimleyana 20: 1-109.

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Relyea, K. and B. Sutton. 1975. A new troglobitic crayfish of the genus *Procambarus* from Florida (Decapoda: Astacidae). Tulane Studies in Zoology and Botany 19: 8-16.

Streever, W.J. 1996. Energy economy hypothesis and the troglobitic crayfish *Procambarus erythrops* in Sim's Sink cave, Florida. American Midland Naturalist 135: 357-366.

Walsh, S.J. 2001. Freshwater macrofauna of Florida karst habitats. Pp. 78-88 in E.L. Kuniansky, ed. U.S. Geological Survey Karst Interest Group Proceedings, Water-Resources Investigations Report 01-4011.

Appendix 1. Biological Review Group Member Biographies

David Cook received his B.S. in Biology from Brown University and his M.S. in Zoology from the University of Florida. He has worked for 24 years as a nongame biologist with GFC/FWC, with primary emphasis on reptiles, amphibians, and invertebrates. He currently serves as the Invertebrate Taxa Coordinator in the FWC's Species Conservation Planning Section, and has drafted management plans on the flatwoods salamander, Panama City crayfish, and Miami blue butterfly.

Richard Franz received his M.S. at the University of Montana. He is an Emeritus, Associate Scientist in Ecosystem Conservation with the Florida Museum of Natural History and an Emeritus, Affiliate Associate Scientist in Wildlife Ecology and Conservation at the University of Florida. He has been studying the ecology and systematics of Florida crayfish for more than forty years. He has conducted field studies and surveys on both the Black Creek and Santa Fe cave crayfish, and published scientific papers on both of these species.

Paul Moler received his B.A. in Biology from Emory University and his M.S. in Zoology from the University of Florida. He worked for 29 years as a research biologist with GFC/FWC, with primary emphasis on reptiles and amphibians. He retired in 2006. Over the last 10 years, he has increasingly focused on research and conservation of Florida's freshwater crayfish and is currently completing a Commission funded genetic assessment of the cave crayfishes of Florida.

Appendix 2. Summary of letters and e-mails received during the solicitation of information from the public.

None received.

Appendix 3. Information and comments received from independent reviewers

To be added after peer review.