

Reviewer Name	Question Prompt	Comment	Review type
Anthony Echelle	1. SPECIES NEEDS             1a. Is our description and analysis of the species' needs, biology, habitat, niche, evolutionary adaptations, life history, and traits accurate and clear?	Yes. A few suggestiions for improvement are included in the attached review.	Peer
Anthony Echelle	1b. Does this description create a clear foundation for the condition assessment?	Yes. But suggestiions for improvement are included in the attached review.	Peer
Anthony Echelle	2. CONDITION             2a. Where information is available, does the SSA report provide accurate and adequate review and analysis of the following:             i. Historical and current distribution of the species and the availability and distribution of suitable habitat,             ii. Trends in species and population abundance, and             iii. Any other relevant metrics of historical and current species health?	Yes. Clear and adequate.	Peer
Anthony Echelle	3. RISK AND FUTURE VIABILITY             3a. Do the future projections represent plausible future threats and species responses?	Yes. As indicated in the attached review, I think there is a place or two where the threat of introgression by Sheepshead Minnow should be given more emphasis.	Peer
Anthony Echelle	3b. Are the conclusions of species future viability based on the species' biology?	Yes	Peer
Anthony Echelle	3c. Is the assessment of future viability clearly explained and supported by available information?	Yes. Again, as indicated in the attached review, I think there is a place or two where the threat of introgression by Sheepshead Minnow should be given more emphasis.	Peer
Anthony Echelle	3d. Does the assessment of future viability provide a clear and applicable description of risks to the species?	Yes	Peer
Anthony Echelle	4. LOGIC AND TRANSPARENCY             4a. Are there any significant oversights, omissions, or inconsistencies in our SSA report?	No. Very thorough.	Peer
Anthony Echelle	4b. Are the conclusions we reach logical and supported by the evidence we provide?	Yes.	Peer

Reviewer Name	Question Prompt	Comment	Review type
Anthony Echelle	4c. Are our assumptions and uncertainties, as well as their impact on the assessment clear?	Yes.	Peer
Anthony Echelle	4d. Are our methods for assessing the species' transparent and repeatable?	Yes.	Peer
Anthony Echelle	4e. Did we include all the necessary and pertinent literature to support our assumptions, arguments, and conclusions? If you find that our data are inadequate, please identify additional data or studies that are needed to adequately evaluate the biological status of the subspecies. Please provide full citations (including relevant page numbers) or attach any additional literature and data to your submission.	Yes. Although I did add three references on predation by non-natives. See attached review.	Peer
Anthony Echelle	5. OTHER COMMENTS   5a. Do you have any other comments pertaining to the scientific information and analyses you would like to provide?	In the attached review, I provide a number of substantive comments and a list of minor typos and edits.	Peer
Anthony Echelle	6. FOR TECHNICAL REVIEWERS ONLY (peer reviewer should please leave this blank):   6a. In the draft report, did we accurately interpret and fully incorporate any information and/or data you provided during the development of the SSA?		Peer
Anthony Echelle	Before submitting your review, we require that you provide the completed Conflict of Interest form. The Conflict of Interest form was attached to your invitation email. If you have not yet done so, please complete the form now and upload it as an attachment. To do so, click the "Upload Reviewer Attachments" button at the top of this page.    When finished, please confirm you have completed this required step.	I have completed and attached the Conflict of Interest form.	Peer

Reviewer Name	Question Prompt	Comment	Review type
Christopher Hoagstrom	<p>1. SPECIES NEEDS</p> <p>&lt;br&gt;</p> <p>1a. Is our description and analysis of the species' needs, biology, habitat, niche, evolutionary adaptations, life history, and traits accurate and clear?</p>	<p>Line 65 - The executive summary says the pupfish is a 'mostly aquatic species'. I don't know what this means, but it is odd and misleading. The Pecos pupfish is an aquatic species. There is no terrestrial, subterranean, aerial, or extraterrestrial life stage. I see no mention of non-aquatic aspects of the Pecos pupfish anywhere in the draft.</p> <p>Line 319 - Pecos pupfish is not closely related to sheepshead minnow. These are from distinct lineages that separated roughly 4.6 million years ago (MA) (Echelle et al. 2005). Close relatives of Pecos pupfish are Leon Springs pupfish (the sister species) and the two forms of Red River pupfish (Red River &amp; Brazos River forms), which are sister to the Pecos-Leon Springs pupfish clade. See also Hoagstrom &amp; Osborne (2021).</p> <p>Line 322 - The Pecos pupfish and Leon Springs pupfish are sister species. The present wording makes this sound unresolved, when in fact it is well documented and reasonable as describe in the cited papers along with, the most important paper (not cited), Echelle et al. (2005).</p> <p>Lines 325-331 - I guess this is included to address historical uncertainty, but I would leave this out. Everything is uncertain until it is figured out and this seems to be going over old ground and creating possible uncertainty where none now exists. For any species you could go back to a time when it wasn't understood because it hadn't yet been studied in detail (this goes without saying).</p>	Peer

Reviewer Name	Question Prompt	Comment	Review type
Christopher Hoagstrom	1b. Does this description create a clear foundation for the condition assessment?	No, the above comments should be addressed to clarify the biology of Pecos pupfish. Also, I was surprised when I reached section 5 that emphasizes climate change when the earlier sections emphasize sheepshead minnow invasion. There is a dramatic disconnect between earlier and later sections. I believe the emphasis on climate change is more valid. Saying this, I believe many of my detailed comments will help better align the introductory information with section 5. However, I also believe there should be additional emphasis on habitat integrity as this will interact with climate change and with sheepshead minnow threat.	Peer
Christopher Hoagstrom	2. CONDITION   2a. Where information is available, does the SSA report provide accurate and adequate review and analysis of the following:   i. Historical and current distribution of the species and the availability and distribution of suitable habitat,   ii. Trends in species and population abundance, and   iii. Any other relevant metrics of historical and current species health?	I have expressed some general concerns in my comments above.	Peer

Reviewer Name	Question Prompt	Comment	Review type
Christopher Hoagstrom	<p>3. RISK AND FUTURE VIABILITY</p> <p>&lt;br&gt;</p> <p>3a. Do the future projections represent plausible future threats and species responses?</p>	<p>Line 744 - In my opinion, the primary cause of reduction in range of Pecos pupfish is habitat destruction. The place where sheepshead minnow have invaded and replaced Pecos pupfish is a highly degraded and industrialized system with essentially no resemblance to pre-industrial habitat conditions (Hoagstrom 2003, 2009). There is no reason to believe that sheepshead minnow would have taken over if habitat had remained pristine (of course, this is impossible to test). Childs et al. (1996) concluded that Pecos pupfish had declined to a very low population number before the invasion of sheepshead minnow. This agrees with the hypothesis that habitat degradation was the primary cause of Pecos pupfish decline. No doubt, sheepshead minnow are a severe threat (Rosenfield et al. 2004, attached), but this cannot be separated from the stark fact that extreme levels of total habitat destruction occurred prior to and likely facilitated their invasion (Hoagstrom and Brooks 1999, Hoagstrom 2003, 2009). Kodric-Brown and Rosenfield (2004, attached) stated in their abstract "Our results suggest that large, stable <i>C. pecosensis</i> populations may be relatively resistant to hybridization with <i>C. variegatus</i>."</p> <p>How can we know whether sheepshead minnow or habitat degradation are the preeminent threat to Pecos pupfish? Compare the habitats where Pecos pupfish persist to those where sheepshead minnow have taken over. Are the same habitats found in both places with only presence of sheepshead minnow being the difference? No! The places where sheepshead minnow have taken over are all severely degraded habitats. The places where Pecos pupfish persist are protected habitats, relatively pristine, albeit, also protected from sheepshead</p>	Peer

Reviewer Name	Question Prompt	Comment	Review type
Christopher Hoagstrom	3b. Are the conclusions of species future viability based on the species' biology?	<p>Line 821 - This statement is an oversimplification. Yes, Pecos pupfish are tolerant of water quality extremes, but this does not mean they persist long term in highly salty habitat or otherwise degraded waters. Certainly, long-term persistence relies on there being a range of fresh to brackish water (not hypersaline). It would be best in this section to summarize the range of water qualities associated with Pecos pupfish and a good assumption would be that the middle of this range (i.e., mean with standard deviation) is characteristic of what the species best uses. Similarly, I would expect a review here of what types of water contamination are present within the historical range of Pecos pupfish. Are there TMDLs or other water-quality concerns documented in the region? What specific contaminants are a concern and what are their sources? I presume there is EPA documentation. What about the New Mexico Environment Department? A great example is that Pecos pupfish used to live in Laguna Grande in Eddy County, NM, but this population declined and evidently disappeared as the lake was increasingly salinized by some combination of continued use as an evaporation pond and decline of spring flows around the lake. Pecos pupfish are not indestructible.</p> <p>Line 1241 - why wasn't water-quality impairment mentioned in the earlier description of water-quality threats (Line 821)?</p> <p>Line 834 - again, oversimplification. Note, the Propst (1999) citation is just a general statement given long ago and based on no specific data. Most Great Plains fishes are tolerant of warm conditions, but are living near their thermal maxima (Matthews &amp; Zimmerman 1990, attached &amp;</p>	Peer
Christopher Hoagstrom	3c. Is the assessment of future viability clearly explained and supported by available information?	<p>Line 1182 - I don't think the statement "While pupfish notably do not require deep pools or continually flowing water," has empirical support. What is the source of this information? I caution against sweeping statement like this. Earlier, it was stated that pupfish habitats are all associated with spring sources, which seems in conflict with this statement. Deeper water habitats may not be critical all year, but could be important seasonally, especially in winter (also, the term 'deep' is subjective, so it is unclear what is meant here).</p>	Peer

Reviewer Name	Question Prompt	Comment	Review type
Christopher Hoagstrom	3d. Does the assessment of future viability provide a clear and applicable description of risks to the species?	<p>Line 1318 - it is a bit strange to make a statement about 'recent trends' citing a publication that is 20 years old (Land 2003). What has happened in the last 20 years? Does anyone know?</p> <p>Line 1330 - Hoagstrom et al. (2015), cited elsewhere, provides detailed data on this unit. Evidence provided there demonstrates Pecos pupfish are widespread throughout this unit. Collyer et al. (2015) also provide information on this population as do Farrington et al. (2010).</p> <p>Line 1345 - for this unit, I would also mention golden algae (Zymonas and Propst 2007, attached).</p> <p>Line 1357 - again, the habitat degradation in this reach is ignored. Compare the habitat in this reach with the habitat anywhere else Pecos pupfish occur. Would you say it is equally pristine or would you say it is the most degraded habitat within the range of Pecos pupfish? I would say the latter. The river channel and flow regime are completely unnatural, unlike the Pecos River farther upstream. It is often dewatered and highly salinized and has a history of other types of pollution. The negative impacts of salinization on the entire ecosystem are documented in a series of studies (e.g., East et al., 2017; Pease and Delaune, 2021). Golden algae blooms are a problem here (this is where they were first detected) (Rhodes and Hubbs 1992), yet only hybridization with sheepshead minnow is emphasized in the draft. No study has shown empirically that hybridization was the main impact here and as I have already mentioned, Childs et al. (1996) actually indicated that Pecos pupfish had likely already declined before</p>	Peer
Christopher Hoagstrom	4. LOGIC AND TRANSPARENCY  4a. Are there any significant oversights, omissions, or inconsistencies in our SSA report?	See detailed comments elsewhere.	Peer
Christopher Hoagstrom	4b. Are the conclusions we reach logical and supported by the evidence we provide?	See detailed comments above.	Peer
Christopher Hoagstrom	4c. Are our assumptions and uncertainties, as well as their impact on the assessment clear?	More or less, but mostly of a highly qualitative nature.	Peer

Reviewer Name	Question Prompt	Comment	Review type
Christopher Hoagstrom	4d. Are our methods for assessing the species' transparent and repeatable?	More or less, but mostly of a highly qualitative nature.	Peer
Christopher Hoagstrom	4e. Did we include all the necessary and pertinent literature to support our assumptions, arguments, and conclusions? If you find that our data are inadequate, please identify additional data or studies that are needed to adequately evaluate the biological status of the subspecies. Please provide full citations (including relevant page numbers) or attach any additional literature and data to your submission.	See detailed comments above.	Peer
Christopher Hoagstrom	5. OTHER COMMENTS   5a. Do you have any other comments pertaining to the scientific information and analyses you would like to provide?	Line 276 - editorial issue - "We evaluate the current biological status of the candy darter..." Line 297 - there is a new (8th) edition of the common and scientific fish names (Page et al. 2023, AFS Special Publication 37, see AFS bookstore), it would be best to use the most recent version Line 454 - grammatical issue, the word 'data' is plural (a datum is a single piece of data). Reword to - "Additionally, data suggest..." Line 474 - grammatical issues, "Pecos pupfish prefer environments with little to know water flow, and, in areas with flows, the typically occupy polls and shallow runs and riffles" - sentence needs careful editing and spell checking. Line 775 - should cite Echelle et al. 1997 here as this paper details this event. Line 777 - grammatical issue - should say "...that data indicate that..." (not that data indicates that) Line 819 - this sentence is difficult to understand "Water reduction and high levels of rain fall in the 1970's led to a reversal in long-term hydraulic head declines in this aquifer (Land and Newton 2008, p. 190)." I think it means reductions in water use? Line 1225 - data indicate (not indicates) Line 1227 - to instead of so - this whole section needs more careful editing for grammar and punctuation Line 1651 - Table 7 runs off the page (could not view right columns) Line 1657 - same issue	Peer



Reviewer Name	Question Prompt	Comment	Review type
Christopher Hoagstrom	<p>6. FOR TECHNICAL REVIEWERS ONLY (peer reviewer should please leave this blank):</p> <p>&lt;br&gt;</p> <p>6a. In the draft report, did we accurately interpret and fully incorporate any information and/or data you provided during the development of the SSA?</p>		Peer
Christopher Hoagstrom	<p>Before submitting your review, we require that you provide the completed Conflict of Interest form. The Conflict of Interest form was attached to your invitation email. If you have not yet done so, please complete the form now and upload it as an attachment. To do so, click the "Upload Reviewer Attachments" button at the top of this page.</p> <p>&lt;br&gt;&lt;br&gt;</p> <p>When finished, please confirm you have completed this required step.</p>	I have completed and attached the Conflict of Interest form.	Peer
John Pittenger	<p>1. SPECIES NEEDS</p> <p>&lt;br&gt;</p> <p>1a. Is our description and analysis of the species' needs, biology, habitat, niche, evolutionary adaptations, life history, and traits accurate and clear?</p>	Relatively so, needs editing to make document more concise.	Peer
John Pittenger	<p>1b. Does this description create a clear foundation for the condition assessment?</p>	Yes	Peer
John Pittenger	<p>2. CONDITION</p> <p>&lt;br&gt;</p> <p>2a. Where information is available, does the SSA report provide accurate and adequate review and analysis of the following:</p> <p>&lt;br&gt;</p> <p>i. Historical and current distribution of the species and the availability and distribution of suitable habitat,</p> <p>&lt;br&gt;</p> <p>ii. Trends in species and population abundance, and</p> <p>&lt;br&gt;</p> <p>iii. Any other relevant metrics of historical and current species health?</p>	Yes	Peer

Reviewer Name	Question Prompt	Comment	Review type
John Pittenger	3. RISK AND FUTURE VIABILITY   3a. Do the future projections represent plausible future threats and species responses?	Yes	Peer
John Pittenger	3b. Are the conclusions of species future viability based on the species' biology?	Yes	Peer
John Pittenger	3c. Is the assessment of future viability clearly explained and supported by available information?	Relatively so, as with specie's need discussion the future viability needs editing to make it clearer and more concise.	Peer
John Pittenger	3d. Does the assessment of future viability provide a clear and applicable description of risks to the species?	Yes	Peer
John Pittenger	4. LOGIC AND TRANSPARENCY   4a. Are there any significant oversights, omissions, or inconsistencies in our SSA report?	No	Peer
John Pittenger	4b. Are the conclusions we reach logical and supported by the evidence we provide?	Yes	Peer
John Pittenger	4c. Are our assumptions and uncertainties, as well as their impact on the assessment clear?	Yes	Peer
John Pittenger	4d. Are our methods for assessing the species' transparent and repeatable?	Yes	Peer
John Pittenger	4e. Did we include all the necessary and pertinent literature to support our assumptions, arguments, and conclusions? If you find that our data are inadequate, please identify additional data or studies that are needed to adequately evaluate the biological status of the subspecies. Please provide full citations (including relevant page numbers) or attach any additional literature and data to your submission.	Yes	Peer
John Pittenger	5. OTHER COMMENTS   5a. Do you have any other comments pertaining to the scientific information and analyses you would like to provide?		Peer
John Pittenger	6. FOR TECHNICAL REVIEWERS ONLY (peer reviewer should please leave this blank):   6a. In the draft report, did we accurately interpret and fully incorporate any information and/or data you provided during the development of the SSA?		Peer

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Lewis Land	<p>1. SPECIES NEEDS</p> <p>&lt;br&gt;</p> <p>1a. Is our description and analysis of the species' needs, biology, habitat, niche, evolutionary adaptations, life history, and traits accurate and clear?</p>		Peer
Lewis Land	<p>1b. Does this description create a clear foundation for the condition assessment?</p>		Peer
Lewis Land	<p>2. CONDITION</p> <p>&lt;br&gt;</p> <p>2a. Where information is available, does the SSA report provide accurate and adequate review and analysis of the following:</p> <p>&lt;br&gt;</p> <p>i. Historical and current distribution of the species and the availability and distribution of suitable habitat,</p> <p>&lt;br&gt;</p> <p>ii. Trends in species and population abundance, and</p> <p>&lt;br&gt;</p> <p>iii. Any other relevant metrics of historical and current species health?</p>		Peer
Lewis Land	<p>3. RISK AND FUTURE VIABILITY</p> <p>&lt;br&gt;</p> <p>3a. Do the future projections represent plausible future threats and species responses?</p>		Peer
Lewis Land	<p>3b. Are the conclusions of species future viability based on the species' biology?</p>		Peer
Lewis Land	<p>3c. Is the assessment of future viability clearly explained and supported by available information?</p>		Peer

Reviewer Name	Question Prompt	Comment	Review type
Lewis Land	3d. Does the assessment of future viability provide a clear and applicable description of risks to the species?		Peer
Lewis Land	4. LOGIC AND TRANSPARENCY   4a. Are there any significant oversights, omissions, or inconsistencies in our SSA report?		Peer
Lewis Land	4b. Are the conclusions we reach logical and supported by the evidence we provide?		Peer
Lewis Land	4c. Are our assumptions and uncertainties, as well as their impact on the assessment clear?		Peer
Lewis Land	4d. Are our methods for assessing the species' transparent and repeatable?		Peer
Lewis Land	4e. Did we include all the necessary and pertinent literature to support our assumptions, arguments, and conclusions? If you find that our data are inadequate, please identify additional data or studies that are needed to adequately evaluate the biological status of the subspecies. Please provide full citations (including relevant page numbers) or attach any additional literature and data to your submission.		Peer
Lewis Land	5. OTHER COMMENTS   5a. Do you have any other comments pertaining to the scientific information and analyses you would like to provide?		Peer
Lewis Land	6. FOR TECHNICAL REVIEWERS ONLY (peer reviewer should please leave this blank):   6a. In the draft report, did we accurately interpret and fully incorporate any information and/or data you provided during the development of the SSA?		Peer
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Page Number	Chapter	Line Number	Comment	Reviewer
iii	Exec Sum	66	You say, "The primary factors impacting the viability of Pecos pupfish are related to habitat: the loss and decline of water quantity, and the degradation of water quality." I would modify as follows: "The primary abiotic factors impacting viability of Pecos pupfish are (1) the loss and decline of surface-waters and (2) degradation of water quality. The primary biotic factor is hybridization with and genetic introgression by the introduced Sheepshead Minnow."	Anthony Echelle
		1	267 delete "10"	Anthony Echelle
		1	276 replace "the candy darter" with "the Pecos pupfish"	Anthony Echelle
		2	322 change "to" to "to be" [or just delete the "to."	Anthony Echelle
		2	327 change "Pecos River" to "Pecos River Basin" because Leon Springs is not in the Pecos River.	Anthony Echelle
		2	329 You say, "until an extant population of Leon Springs pupfish was found at Leon Springs, Pecos County, Texas . . ." Change to read ". . . was found in Diamond Y Draw, Pecos County, Texas . . ." Explanation: The extant population occurs in Diamond Y Draw. Leon Creek, which includes the now dry Leon Springs, is a tributary of Diamond Y Draw.	Anthony Echelle
		2	334 Change "Cyprinodon phylogenetic relationships" to "relationships of Pecos pupfish."	Anthony Echelle
		2	354 You say, "On Bitter Lake NWR two distinct clusters were observed that may indicated gene flow." Change underlined to read, "that likely reflects restricted gene flow."	Anthony Echelle
		2	395 Doege 2023—Not in Literature Cited	Anthony Echelle
		2	404 Table 1: For egg requirements delete, "Topographic diversity with silty substrate to adhere to." Pupfish avoid silt for spawning. In silt-laden situations, they prefer hard substrates.	Anthony Echelle
		2	408 You say, "As with most pupfish, the Pecos pupfish requires a silty substrate, water depths less than two meters (m) 410 deep, and areas with topographic diversity for spawning (Kodric-Brown 1977, pp. 750–751)."  I don't think pupfish "require" silty substrate for spawning or anything else, and my reading of the cited pages in Kodric-Brown (1977) does not say this. You might reword to read ". . . often occurs in quiet waters less than two meters . . ."	Anthony Echelle
		2	444 "be reflective [of] habitat" [insert "of"]	Anthony Echelle

Page Number	Chapter	Line Number	Comment	Reviewer
	2	475	Typos (underlined), "Pecos pupfish prefer environments with little to <u>know</u> water flow, and, in areas with flows, the typically occupy polls . . ." change to "no," "they," and "pools."	Anthony Echelle
	2	528	After "County," insert "Texas."	Anthony Echelle
	2	582	You say, "These are events that are reasonably likely to occur, however, occur infrequently enough that they can drastically alter the ecosystem where they happen." This needs rewording—how about? "These events occur frequently enough that they can drastically alter local ecosystems."	Anthony Echelle
	2	714	Change "move" to "dispersal"	Anthony Echelle
	3	759	Change "Conor" to "Connor"	Anthony Echelle
	3	897	Add the following to end of paragraph: "Childs et al. (1996) speculated that the spread of hybrid Pecos pupfish x Sheepshead minnow in Salt Creek upstream from its mouth occurred during a period when abundance of the native Pecos pupfish was low, possibly because of an undocumented fish kill caused by an algal bloom."	Anthony Echelle
39	3	923	I suggest replacing the paragraph beginning on this line with the following: "The effect of predation by other fishes, birds, etc. on Pecos pupfish populations is unknown. However, hybrid Pecos pupfish x Sheepshead minnow are a primary dietary item for the non-native gulf killifish ( <i>Fundulus grandis</i> ) in the lower Pecos (East et al. 2017). Also, elsewhere in the Southwest, predation by non-native fishes is implicated in the decline of Desert pupfish ( <i>C. macularius</i> ) (Schoenherr 1981) and the extinction of Monkey spring pupfish ( <i>C. arcuatus</i> ) (Minckley et al. 2002)."  East, J. L., C. Wilcut, and A. A. Pease. 2017. Aquatic food-web structure along a salinized dryland river. <i>Freshwater Biology</i> 62:681-694.  Minckley, W. L., R. R. Miller, and S. M. Norris. 2002. Three new Pupfish species, <i>Cyprinodon</i> (Teleostei, Cyprinodontidae), from Chihuahua, Mexico, and Arizona, USA. <i>Copeia</i> 2002:687-705.  Schoenherr, A. A. 1981. The role of competition in the displacement of native fishes by introduced species, p. 173-203. In: <i>Fishes in North American deserts</i> . R. J. Naiman and D. L. Soltz (eds.). Wiley, NY.	Anthony Echelle

Page Number	Chapter	Line Number	Comment	Reviewer
		3 942	You say, "Overall, the introgression of the sheepshead minnow coupled with one or all of these stressors will greatly reduce the viability of the species." I suggest changing underlined wording to read, "introgression by sheepshead minnow alone or coupled with."	Anthony Echelle
		4 1162	You say, "However, at salinities greater than 35,000 1163 mg/L, larval and egg development are suppressed (Kinne and Kinne 1962) After "suppressed" add "in Desert pupfish, <i>Cyprinodon macularius</i> " Otherwise, it sounds like this is known specifically for Pecos pupfish.	Anthony Echelle
		4 1451	You say, "suggest that Pecos pupfish morphology differs depending on the environmental setting" Follow "setting" with, ", a result that might reflect either developmental plasticity or local genetic adaptation."	Anthony Echelle
		5 1497	You say, "Given these factors, we think the most important future influences on Pecos pupfish viability will result from potential changes in water availability." I suggest changing "future influences on" to read "abiotic factors affecting." Then add the following as a new sentence: "The most important biotic factor is the potential for hybridization and genetic introgression by Sheepshead minnow."	Anthony Echelle
		General	This status assessment for the Pecos Pupfish does an excellent job with the stated purpose of providing "the biological support for the decision on whether or not to propose to list the species as threatened or endangered."	Anthony Echelle
		General	I assume that there will be copy-editing for minor corrections to the wording, but, at the end of this review, I list a number of typos and minor edits to consider.	Anthony Echelle
iii	Exec Sum	65	The executive summary says the pupfish is a 'mostly aquatic species'. I don't know what this means, but it is odd and misleading. The Pecos pupfish is an aquatic species. There is no terrestrial, subterranean, aerial, or extraterrestrial life stage. I see no mention of non-aquatic aspects of the Pecos pupfish anywhere in the draft.	Christopher Hoagstrom
		2 276	editorial issue - "We evaluate the current biological status of the candy darter..."	Christopher Hoagstrom
		2 297	there is a new (8th) edition of the common and scientific fish names (Page et al. 2023, AFS Special Publication 37, see AFS bookstore), it would be best to use the most recent version	Christopher Hoagstrom
		2 395	here it correctly states the Pecos pupfish and Leon Springs pupfish are sister species, when earlier in the document this was not clearly stated and the tentative wording communicated uncertainty (see my earlier comments). Improving consistency of message throughout the document and limiting the message of uncertainty to where it is a real issue would strengthen it.	Christopher Hoagstrom

Page Number	Chapter	Line Number	Comment	Reviewer
	2	404	Table 1 - I would not use the temperature for peak spawning as required for the species. Certainly Pecos pupfish spawn successfully at temperatures lower than 30 degrees C. I would go back and revisit the cited publications and report the full range of temperatures at which spawning occurs, not just the peak spawning.	Christopher Hoagstrom
	2	404	spawning substrate - this is confusing. It says silty substrate is required, but later says limestone embankments (i.e., rocky substrates) are most desirable breeding substrate. This should be clarified. It is truly unusual for fishes to place eggs on silt because silt will suffocate eggs, which need to exchange gases. It is more likely Pecos pupfish, like other fishes, place their eggs on non-silty substrates (like limestones and vegetation), to protect the eggs from suffocation. I would double check these references to see specifically where egg placement has been documented and revise table 1 and this section accordingly. Certainly, Pecos pupfish in general associate with silt substrates, but this is not a good substrate for laying eggs and typically vegetation or rocky substrates are available for spawning. Echelle et al. (1990, attached) cite similar sources to those in this draft, but state in the last paragraph "...demonstrates that [breeding] territories are typically associated with "high-quality" sites defined by female preference for spawning substrate, typically hard surfaces of prominent topographic features."	Christopher Hoagstrom
	2	408	same thing as line 404, report the full range of temperatures used for spawning, not just the peak. Pecos pupfish are tolerant and adaptable.	Christopher Hoagstrom
	2	422	this statement agrees with my concerns in the preceding comment. Eggs that adhere to substrate would not work well in silt. The silt would stick to and cover the egg and restrict gas exchange, causing suffocation. The benefit of sticky eggs would be to place them on vegetation or rocks to keep them out of the silt.	Christopher Hoagstrom
	2	454	grammatical issue, the word 'data' is plural (a datum is a single piece of data). Reword to - "Additionally, data suggest..."	Christopher Hoagstrom
	2	464	citation issue, do not cite Hoagstrom and Osborne (2021) here, they did not study habitat use. However, it would make sense to cite Hoagstrom and Brooks (1999) here, because these authors provided detailed data on all Pecos pupfish habitats, which is much more extensive of a data set than provided by Propst (1999) or Collyer et al. (2015), which were both based on Hoagstrom and Brooks (1999). There is no other document that provides detailed habitat information across the whole range of Pecos pupfish as in Hoagstrom and Brooks (1999).	Christopher Hoagstrom
	2	474	grammatical issues, "Pecos pupfish prefer environments with little to know water flow, and, in areas with flows, the typically occupy polls and shallow runs and riffles" - sentence needs careful editing and spell checking.	Christopher Hoagstrom



Page Number	Chapter	Line Number	Comment	Reviewer
	2	494	This is an excellent paragraph making an important point for Pecos pupfish conservation. The only thing I would add is that this lack of connectivity is anthropogenic. Prior to industrial and agricultural developments. All Pecos pupfish habitats would have been generally connected when the water table was at ground level (prior to groundwater pumping) and flooding was natural (prior to damming).	Christopher Hoagstrom
	2	517	here is another place to emphasize that pristine hydrology provided connected habitats with great diversity, while modern hydrology creates fragmentation and isolation among remnant habitats.	Christopher Hoagstrom
	2	531	Hatch (1985) is a very poor reference for the historical condition of the Pecos River. That is not the subject of this very short paper that is focused on Pecos bluntnose shiner. An excellent source for understanding the historical Pecos River is the Pecos River Joint Investigation, Reports of Participating Agencies. There are also a variety of historical accounts, especially of the lower river (see books by Dearen). Hoagstrom and Brooks (1999) provide some references for this, as does Hoagstrom (2003, 2009, attached) and the Hoagstrom et al. (2008) papers cited in this draft.	Christopher Hoagstrom
	2	534	as above (line 531), Hatch et al. (1985) is not a historical study of the Pecos River. Conditions they encountered in the 1980s do not represent the Pecos River prior to human impacts. The 1980s marked the 100-year anniversary of damming and agricultural development in the Pecos River near Carlsbad. See (for example) attached papers by Hoagstrom (2003, 2009).	Christopher Hoagstrom
	2	537	suggest more care with citations. This sentence is talking about a change in river conditions, but then a paper from 1915 is cited. This 1915 paper can't have been about change that happened later unless the authors could see the future. Perhaps it is meant to be cited as an example of earlier conditions? Maybe a preceding sentence citing this 1915 paper could describe previous conditions and then a following sentence could talk about subsequent change? However, Inoue et al. (2014) is about the Black River, not the Pecos River, so it is a horrible reference for this sentence, which is about the Pecos River (sorry, I don't know how else to say this). Again, books by Dearen or other references from the papers I have already mentioned would be much more appropriate. I know I probably seem like a stickler, but it is these details that will make this document either defensible and accurate and legitimate and a useful resource or not. As this document is revised, I recommend that each reference and citation be carefully evaluated.	Christopher Hoagstrom
	2	583	I do not consider storms to be a disturbance that Pecos pupfish need to withstand. Storms are natural throughout the region inhabited by Pecos pupfish and are beneficial to the species by refreshing desiccating and desiccated habitats and connecting habitats, providing dispersal corridors. Pecos pupfish are adapted to storms and take advantage of opportunities they offer.	Christopher Hoagstrom

Page Number	Chapter	Line Number	Comment	Reviewer
	2	621	I would emphasize that the vast majority of Pecos pupfish distribution was within the Pecos River valley and especially within the Pecos River floodplain. Mainstem and tributary floods were undoubtedly a critical phenomenon that accounted for and maintained the distribution of the species.	Christopher Hoagstrom
30-31	3	744	<p>In my opinion, the primary cause of reduction in range of Pecos pupfish is habitat destruction. The place where sheepshead minnow have invaded and replaced Pecos pupfish is a highly degraded and industrialized system with essentially no resemblance to pre-industrial habitat conditions (Hoagstrom 2003, 2009). There is no reason to believe that sheepshead minnow would have taken over if habitat had remained pristine (of course, this is impossible to test). Childs et al. (1996) concluded that Pecos pupfish had declined to a very low population number before the invasion of sheepshead minnow. This agrees with the hypothesis that habitat degradation was the primary cause of Pecos pupfish decline. No doubt, sheepshead minnow are a severe threat (Rosenfield et al. 2004, attached), but this cannot be separated from the stark fact that extreme levels of total habitat destruction occurred prior to and likely facilitated their invasion (Hoagstrom and Brooks 1999, Hoagstrom 2003, 2009). Kodric-Brown and Rosenfield (2004, attached) stated in their abstract "Our results suggest that large, stable <i>C. pecosensis</i> populations may be relatively resistant to hybridization with <i>C. variegatus</i>."</p> <p>How can we know whether sheepshead minnow or habitat degradation are the preeminent threat to Pecos pupfish? Compare the habitats where Pecos pupfish persist to those where sheepshead minnow have taken over. Are the same habitats found in both places with only presence of sheepshead minnow being the difference? No! The places where sheepshead minnow have taken over are all severely degraded habitats. The places where Pecos pupfish persist are protected habitats, relatively pristine, albeit, also protected from sheepshead minnow. We know that sheepshead minnow are a threat in degraded habitats and they are a potential threat elsewhere, but we can't say for certain they are a threat in the absence of habitat degradation.</p>	Christopher Hoagstrom

Page Number	Chapter	Line Number	Comment	Reviewer
NR	3	760	Again, I am in very strong disagreement with this statement. Clearly, if habitat disappears, there will be no Pecos pupfish, regardless of whether sheepshead minnow are present. On the other hand, sheepshead minnows have threatened the Salt Creek, TX population for decades (for example), but according to this draft, Salt Creek, TX still holds Pecos pupfish. There is a tendency in conservation to look for a scapegoat such as an invasive species because this is more tractable and politically acceptable than the broader problems created by human population growth and resource use. For example, barriers have been constructed in NM to protect Pecos pupfish from sheepshead minnow, which still have not been found above Brantley and thus are not yet even a direct threat to invade, but what has been done to secure, protect, and restore Pecos pupfish habitat? No doubt sheepshead minnow are a threat that needs to be accounted for, but there is no clear evidence that they are a greater threat than habitat loss and no one has evidence to show that sheepshead minnow can invade and wipe out a large, healthy, diverse, population of Pecos pupfish in a pristine habitat (of course, we would rather not test this hypothesis). On the other hand, we don't need a study to know what will happen if groundwater levels continue to decline and/or if the Pecos River ceases to flow and provide connectivity among habitats. Collyer et al. (2015) showed that anthropogenic isolation among habitats causes pupfish morphology to diverge from a normal type that inhabits a connected and diverse wetland ecosystem. This is a concern given that population isolation is human caused. Further, isolated populations developed morphologies in some cases consistent with extreme environmental conditions (e.g., hypoxia), suggesting these populations are vulnerable to subsequent deterioration, which seems likely given ongoing groundwater use and climate change. Ultimately, Pecos pupfish will rely on a reliable water supply to sustain diverse, connected habitats, which means there needs to be water and habitat conservation. Importantly, protecting these habitats protects more than just Pecos pupfish, it supports the wetland ecosystems and all their native species.	Christopher Hoagstrom
32	3	775	should cite Echelle et al. 1997 here as this paper details this event.	Christopher Hoagstrom
	3	777	grammatical issue - should say "...that data indicate that..." (not that data indicates that)	Christopher Hoagstrom
34	3	819	this sentence is difficult to understand "Water reduction and high levels of rain fall in the 1970's led to a reversal in long-term hydraulic head declines in this aquifer (Land and Newton 2008, p. 190)." I think it means reductions in water use?	Christopher Hoagstrom

Page Number	Chapter	Line Number	Comment	Reviewer
NR		3 821	This statement is an oversimplification. Yes, Pecos pupfish are tolerant of water quality extremes, but this does not mean they persist long term in highly salty habitat or otherwise degraded waters. Certainly, long-term persistence relies on there being a range of fresh to brackish water (not hypersaline). It would be best in this section to summarize the range of water qualities associated with Pecos pupfish and a good assumption would be that the middle of this range (i.e., mean with standard deviation) is characteristic of what the species best uses. Similarly, I would expect a review here of what types of water contamination are present within the historical range of Pecos pupfish. Are there TMDLs or other water-quality concerns documented in the region? What specific contaminants are a concern and what are their sources? I presume there is EPA documentation. What about the New Mexico Environment Department? A great example is that Pecos pupfish used to live in Laguna Grande in Eddy County, NM, but this population declined and evidently disappeared as the lake was increasingly salinized by some combination of continued use as an evaporation pond and decline of spring flows around the lake. Pecos pupfish are not indestructible.	Christopher Hoagstrom
		3 834	again, oversimplification. Note, the Propst (1999) citation is just a general statement given long ago and based on no specific data. Most Great Plains fishes are tolerant of warm conditions, but are living near their thermal maxima (Matthews & Zimmerman 1990, attached & referenced below). Global warming is a threat to all these fishes, including Pecos pupfish, because it could increase temperature beyond the tolerable range. Importantly, the anthropogenic fragmentation of Pecos pupfish habitats, which I have already emphasized, makes this a larger concern. In a connected habitat, Pecos pupfish could locate thermal refugia. Now, isolated populations lack this opportunity and must survive in situ in small, isolated habitats. This bodes very ill for these species. Lea Lake and the overflow wetland may be the only habitat that supports a large population and provides ample thermal refugia. Some of the areas on BLNWR may also provide this kind of condition, but this is uncertain as the spring flows and other thermal features are not obvious and have not been assessed in detail or mapped. Because of the unnaturally fragmented nature of Pecos pupfish populations, global warming and associated water-quality change (temperature, salinity) should be a serious concern. My concerns here also seem to align with those in the future analysis below.	Christopher Hoagstrom
		3 841	this paragraph seems vague and is difficult to apply to Pecos pupfish. The last sentence seems important, but no detail is provided. This is exactly the concern I have already expressed in this review. There should be detailed discussion regarding "the demand that is put on surface and ground water availability for the pupfish."	Christopher Hoagstrom

Page Number	Chapter	Line Number	Comment	Reviewer
		3 869	this assessment is incorrect. As already mentioned, habitat destruction in the Pecos River downstream from Carlsbad was directly associated with the decline of Pecos pupfish (Hoagstrom and Brooks 1999). East et al. (2017) and Pease and Delaune (2021) demonstrate the trophic impacts of habitat degradation in the lower Pecos River, where Pecos pupfish historically declined. Although sheepshead minnow may have played a role in the decline of Pecos pupfish, this cannot be separated from the major habitat destruction that occurred prior to sheepshead minnow invasion (see Collyer et al., 2015, penultimate paragraph). Overlooking this evidence leads to a downplaying of the importance of good habitat, to the detriment not only of Pecos pupfish but of all native species and of the Pecos River ecosystem. Habitat conditions for pupfish available in the Pecos River below Carlsbad are in no way comparable to those available at BLNWR and the Lea Lake overflow wetlands. Clearly, the habitats still holding Pecos pupfish in good numbers are unique because they have been uniquely preserved and protected. This is an obvious demonstration that habitat protection is the number one need for Pecos pupfish conservation.	Christopher Hoagstrom
		3 878	Although I agree with these statements, the citation of Hoagstrom et al. (2008b) is questionable. That paper is about Pecos bluntnose shiner and is not specifically relevant to pupfish. It would be better to find a reference more directly related to pupfish and/or more generally focused on habitat fragmentation as it applies to Pecos pupfish.	Christopher Hoagstrom
		3 928	I would list these threats - habitat degradation (including water quality declines) and loss (including water quantity declines), habitat fragmentation, hybridization. Habitat loss and water quantity decline are the same thing. Habitat degradation and water quality decline are the same thing. However, habitat fragmentation is a separate effect that exacerbates habitat loss and degradation (Hoagstrom 2015, attached).	Christopher Hoagstrom
		4 1182	I don't think the statement "While pupfish notably do not require deep pools or continually flowing water," has empirical support. What is the source of this information? I caution against sweeping statement like this. Earlier, it was stated that pupfish habitats are all associated with spring sources, which seems in conflict with this statement. Deeper water habitats may not be critical all year, but could be important seasonally, especially in winter (also, the term 'deep' is subjective, so it is unclear what is meant here).	Christopher Hoagstrom
		4 1225	data indicate (not indicates)	Christopher Hoagstrom
		4 1227	to instead of so - <b>this whole section needs more careful editing for grammar and punctuation</b>	Christopher Hoagstrom
35		4 1241	why wasn't water-quality impairment mentioned in the earlier description of water-quality threats (Line 821)?	Christopher Hoagstrom
		4 1318	it is a bit strange to make a statement about 'recent trends' citing a publication that is 20 years old (Land 2003). What has happened in the last 20 years? Does anyone know?	Christopher Hoagstrom

Page Number	Chapter	Line Number	Comment	Reviewer
		4 1330	Hoagstrom et al. (2015), cited elsewhere, provides detailed data on this unit. Evidence provided there demonstrates Pecos pupfish are widespread throughout this unit. Collyer et al. (2015) also provide information on this population as do Farrington et al. (2010).	Christopher Hoagstrom
38, 64		4 1345	for this unit, I would also mention golden algae (Zymonas and Propst 2007, attached).	Christopher Hoagstrom
		4 1357	again, the habitat degradation in this reach is ignored. Compare the habitat in this reach with the habitat anywhere else Pecos pupfish occur. Would you say it is equally pristine or would you say it is the most degraded habitat within the range of Pecos pupfish? I would say the latter. The river channel and flow regime are completely unnatural, unlike the Pecos River farther upstream. It is often dewatered and highly salinized and has a history of other types of pollution. The negative impacts of salinization on the entire ecosystem are documented in a series of studies (e.g., East et al., 2017; Pease and Delaune, 2021). Golden algae blooms are a problem here (this is where they were first detected) (Rhodes and Hubbs 1992), yet only hybridization with sheepshead minnow is emphasized in the draft. No study has shown empirically that hybridization was the main impact here and as I have already mentioned, Childs et al. (1996) actually indicated that Pecos pupfish had likely already declined before introgression with sheepshead minnow. In my view, this draft poorly represents the numerous and interrelated barriers to conservation that are present in the lower Pecos River.	Christopher Hoagstrom

Page Number	Chapter	Line Number	Comment	Reviewer
	4	1364	<p>Table 5 - I'm not sure why genetic security is listed as low for Unit 8. Sheepshead minnow have been present since the mid 1980s, but Pecos pupfish still persist. What is the threat that would change this situation after 40 years? I would reclassify this as medium or moderate, although more study should be done to better understand what maintains separation between Pecos pupfish and sheepshead minnow at this site.</p> <p>For occurrence, I'm unsure why Unit 8 is classified as moderate. The one time I was there (albeit, 20 years ago), there were tons of pupfish. Is there evidence to say there are fewer now? Perhaps this should be classified as a different category, such as more information needed? Is there a threat from fracking? I'm not saying this assessment is wrong, but I'm wondering what information leads to this this conclusion. I don't see this information in the draft.</p> <p>For water quantity, I would classify Unit 5 as moderate. This refers to distinct isolated sinkholes, not extensive wetlands. If the quantity is moderate in the Pecos River, certainly it must also be moderate in the Bottomless Lakes.</p> <p>For water quality, I would classify Unit 6 as high. This is a spring fed system with little stagnation and certainly has better water quality than Unit 5, which includes some relatively stagnant sinkholes. Is Unit 8 classified as low due to fracking? Nothing is mentioned about this in the narrative (lines 1351-1356).</p> <p>For habitat diversity I would rate Unit 2 as low or moderate, Unit 5 as low, Unit 9 as low.</p> <p>Overall condition, I would rate Unit 5 as moderate.</p>	Christopher Hoagstrom
	4	1379	<p>based on information in Childs et al. (1996) and Kodric-Brown and Rosenfield (2004) the statement "A well-connected Pecos pupfish population is one that allows for dispersal and recolonization but is also one that is at increased risk of introgression." is poorly supported. These authors suggest that a large and healthy population is more resistant to hybridization. Fragmentation creates many risks. A great way to increase extinction risk is to increase fragmentation. Importantly, it should be noted that healthy Pecos pupfish populations occur where there is abundant, diverse, interconnected habitat.</p>	Christopher Hoagstrom

Page Number	Chapter	Line Number	Comment	Reviewer
		4 1476	Section 5.1 - While I generally agree with the focus on climate change impacts for future scenarios, it is important to note that habitat conditions interact with climate to provide potential refugia (or not). Better habitat conditions and habitat connectivity can reduce or buffer effects of warming and provide opportunities for pupfish to seek out refugia.	Christopher Hoagstrom
		5 1651	Table 7 runs off the page (could not view right columns)	Christopher Hoagstrom
		5 1657	same issue as line 1651 (table runs off page)	Christopher Hoagstrom
		5 1746	It should be noted that at present, sheepshead minnow do not occur in the Pecos River above Brantley Dam, so at present, Brantley Dam is a barrier between sheepshead minnow and every unit upstream (units 1-6). The barriers placed on upstream units at present are preemptive and at present are not serving any conservation function.	Christopher Hoagstrom
		5 1782	should add to this the effects of habitat degradation and fragmentation. Poorer habitat provides less habitat resilience to climate change. More fragmented habitat increases risk of adverse effects from climate change.	Christopher Hoagstrom
		5 1792	this is a highly qualitative assessment based mostly on patchy, descriptive information with little empirical much less experimental rigor. I would use less absolute terminology. I would say something like "indicating multiple areas across the species core range to have potential for high resiliency, if our assessment is reasonably accurate."	Christopher Hoagstrom
		5 1835	although I heartily agree that the goal should be to stop sheepshead minnow spread, this statement is highly speculative. It would be better just to state that sheepshead minnow spread should be entirely avoided if at all possible and opportunities to reduce the sheepshead minnow population where they occur should be sought (I don't know why this is never mentioned). We don't know what the exact outcome would be if the species was spread to other Pecos pupfish localities, but the prudent approach is to limit the spread.	Christopher Hoagstrom
		1 200	This highlighted section is redundant. The same information is presented in the second paragraph, which seems to be a better place for it.	John Pittenger
		1 202	delete "substantial"	John Pittenger
		1 240	Remove parentheses before Wolf et al., 2015	John Pittenger
		1 267	Remove 10	John Pittenger
		1 276	replace candy darter with Pecos pupfish	John Pittenger



Page Number	Chapter	Line Number	Comment	Reviewer
	2	348	I could not find a copy of Whiteley (2023) online. What is this source? A source with the same title is available online by Amish (2023) as an NMDGF report (attached). The citation provided for Whiteley (2023) in this draft contains no information by which to obtain this source, so I could not find it. My review is incomplete without this information and I cannot verify the interpretations provided in the draft document. However, I am skeptical of the way this is written as the Amish (2023) report shows very little variation among populations (their PCAs explain <4% of variation, which means location is not a good predictor of genetic variation, meaning there isn't really any geographical genetic structure. This is to be expected for a species that is highly mobile and occupies short-lived, dynamic habitats).	John Pittenger
	2	351	Principal Component Analysis (PCA)	John Pittenger
	2	409	I'm not sure that a silty substrate is necessarily required for spawning. As I understand it Kodric-Brown's study site at Mirror Lake had silty substrate, but on page 70 she notes that "Territories are established in water less than 2 m deep, over certain substrates that are suitable for oviposition and provide topographic diversity."	John Pittenger
	2	417	This contradicts the earlier statement that silty substrates are required for spawning.	John Pittenger
	2	444	be reflective of	John Pittenger
	2	474	no, not know	John Pittenger
	2	474	they, not the	John Pittenger
	2	475	pools, not polls	John Pittenger
	2	479	delete "being found"	John Pittenger
	2	491	Would be better to replace "BEEC" throughout with "Blue Earth" as I noted in the Literature Cited edit.	John Pittenger
	2	509	Maybe more appropriate to say "currently" rather than "always"?	John Pittenger
	2	509	"allowing for" instead of "providing"?	John Pittenger
	2	531	suggested edit: fairly shallow meandering river (citation) though it typically had...	John Pittenger
	2	540	springs <b>sustained by</b> <del>from underground</del> aquifers that underlay	John Pittenger
	2	549	replace "(i.e." and ")" with such as	John Pittenger
	2	551	aquifers	John Pittenger
	2	581	These are events that are reasonably likely to occur, <del>however, occur</del> <b>albeit</b> infrequently, <del>enough</del> that they can drastically alter <del>habitats</del> <b>the ecosystem where they happen.</b>	John Pittenger
	2	586	Would it be more appropriate to say "spatial distribution"? In my mind, habitat diversity refers to something else	John Pittenger
	2	618	It would be good to be consistent, either using state abbreviations or spelling out state names throughout.	John Pittenger
	2	625	replace "," with "and after NWR	John Pittenger
	2	648	Not sure what "inlet" refers to; maybe delete the word?	John Pittenger
	2	677	replace comma with period, capitlaize Water	John Pittenger

Page Number	Chapter	Line Number	Comment	Reviewer
	2	695	Replace Pittenger with Blue Earth	John Pittenger
	2	697	add Upper and Lower before Figure 8 (and delete from parentheses)	John Pittenger
	3	739	<p>I found this diagram to be confusing, particularly with respect to the positive and negative influence arrows. For example, it suggests that pollution is negatively affected by climate change, implying that climate change reduces the influence of pollution. Further, it indicates that pollution has a positive influence on adult survival. Another example is water quality having a negative effect on fecundity and distribution, but it doesn't distinguish between good water quality and bad water quality. The diagram doesn't distinguish the state of a factor (high or low, good or poor, etc.) in the type of effect it has (positive or negative).</p> <p>One suggestion would be to change the titles of the green ellipses to "Appropriate Water Quality", "Adequate Water Quantity" and "Sufficient Habitat Connectivity" to give some indication of the state of the habitat factor that is being influenced or that influences other factors. The influence arrows should then be re-examined to see if they need to be edited.</p>	John Pittenger
	4	1002	There is no Table 5.1, not sure what "range" is being referenced	John Pittenger
	4	1004	Unclear where the range 0-33 comes from.	John Pittenger
	4	1015	There is no Table 4.2	John Pittenger
	4	1210	Current condition, as summarized in Table 5, doesn't appear to consider redundancy and representation. So I'm not clear on how all three R's are combined in assessing current condition of each unit.	John Pittenger
	4	1220	Table X is Table 4	John Pittenger
	4	1248	Could the mortality have been the result of very low flow (and lack of deeper water thermal refuge habitat) coupled with low water temperature (i.e. winter kill)?	John Pittenger
	4	1423	Table numbering is inconsistent with previous tables.	John Pittenger
	4	1459	should resiliency be "representation"?	John Pittenger
	4	1460	should resiliency be "representation"?	John Pittenger
	4	1463	Section 4.4.4: This is confusing, as the terms "viability" and "condition" appear to be used interchangeably, and this paragraph seems redundant with previous text.	John Pittenger
	5	1492	Odd citation - would be better just to show it as a figure	John Pittenger
	5	1505	These should be named and defined here, maybe as they are named in the legend in Figure 30, and defined using the corresponding Representative Concentration Pathway (RCP) scenario (e.g. 4.5, 8.5).	John Pittenger
	5	1541	Table 5 does not indicate which RCP scenario corresponds to which SSA future scenario.	John Pittenger
	5	1546	should this be Figure 32?	John Pittenger
	5	1547	There is no Figure 32.	John Pittenger
	5	1557	should this be Figure 33?	John Pittenger

Page Number	Chapter	Line Number	Comment	Reviewer
		5	1651 Entire table is not visible.	John Pittenger
		5	1651 Suggest rearranging in these tables, putting Existing Condition column first, before future condition columns.	John Pittenger
		5	1736 Table 13?	John Pittenger
89		5	1768 Unit 3: The way this is written throughout the table is confusing. Suggest rewriting these first sentences using this example: "Low risk of introgression; isolated sinkholes are well protected ...", removing the "due to" part and replacing it with a semicolon.	John Pittenger
89		5	1768 Unit 4: Doesn't make sense to say there is a high risk but the sinkholes are well protected. The text indicates vulnerability to sheepshead minnow introgression, in the event of that species gaining a foothold in the Upper Pecos River Unit, is the same as the Salt Creek Wilderness Unit.	John Pittenger
		5	1788 Table 14?	John Pittenger
		5	1803 Analysis Unit: This column appears to be probability of persistence over the analysis time frame, not analysis unit. All of the other columns should be under an overall heading of "number of analysis units."	John Pittenger
		5	1806 Table 14?	John Pittenger
	Lit Cited		1898 Replace BEEC with Blue Earth Ecological Consultants, Inc. (Blue Earth)	John Pittenger
iii	Exec Sum		65 this is a fish we're talking about, so why describe it as "mostly aquatic"?	Lewis Land
		1	214 The first two sentences of this paragraph already occur in the previous paragraph	Lewis Land
		2	414 The bedrock at BLSP is gypsum and mudstone of the Seven Rivers Formation. There are no limestone embankments anywhere in the park	Lewis Land
		2	474 no, not know	Lewis Land
		2	474 they, not the	Lewis Land
		2	475 what is a "poll"? Is this a typo?	Lewis Land
		2	545 Should be Land and Huff, 2010	Lewis Land
		2	549 Buckles, not buckle; there are more than one	Lewis Land
		2	549 Figures 9 and 10	Lewis Land
		2	562 This figure without a legend may be a bit confusing to the non-specialist. For example, the Delaware Basin is not an aquifer, it is a regional tectonic feature, as is the Central Basin Platform.	Lewis Land
		2	681 I believe you mean Figure 11	Lewis Land
		2	701 Do you mean BLSP, rather than BLNWR?	Lewis Land
		3	748 legend needs adjustment	Lewis Land
NR		3	758 you probably mean figure 14	Lewis Land
		3	819 I would phrase this as "reduction in pumping for irrigated agriculture in the artesian basin"	Lewis Land
		3	887 you probably mean "large-scale fish kills"	Lewis Land

Page Number	Chapter	Line Number	Comment	Reviewer
	4	1186	influenced	Lewis Land
	4	1191	I am somewhat skeptical of this statement. I don't believe the Capitan Reef aquifer is present in the subsurface beneath Salt Creek.	Lewis Land
	4	1268	Lake St. Francis, not Francies	Lewis Land
	4	1281	Since I'm being cited here I thought I should check the original publication. In that 2003 paper I state that evaporation rates exceed mean annual *precipitation* in the region, so this statement is incorrect.	Lewis Land
	4	1298	habitat, not habit	Lewis Land
	4	1304	temperature	Lewis Land
	4	1305	when	Lewis Land
	4	1325	this sentence is incomplete	Lewis Land
	4	1363	This sentence is also incomplete	Lewis Land
	4	1367	I could not help but notice that, although you show Brantley Dam in the correct location, that body of water upstream from the dam is not Brantley Lake; it's old Lake McMillan, the predecessor to Brantley Lake. I'm not surprised to see this mistake since the same cartographic error occurs on the state geologic map.	Lewis Land
	4	1401	too	Lewis Land
	5	1547	there is no figure 32. Also, you mean *projected* changes, not project changes	Lewis Land
	5	1554	that	Lewis Land
	5	1556	2010, not 2009	Lewis Land
	5	1565	the word slightly is out of place	Lewis Land
	5	1647	I believe this should be "affected"	Lewis Land
	5	1788	are in moderate what??	Lewis Land
	5	1803	This table is *very confusing*. The first column is labelled "analysis unit", but the cells in that column only have high, moderate, low and extirpated entries. Is this an error or am I just misunderstanding it, because it doesn't make sense as it is.	Lewis Land
	5	1868	This is incorrect. Scenario 2 is defined earlier as Hot and Wet. Scenario 3, below, is warm and dry	Lewis Land
	5	1879	projected, not project	Lewis Land
	Lit Cited	2068	Should be Land and Huff, 2010	Lewis Land

This status assessment for the Pecos Pupfish does an excellent job with the stated purpose of providing “the biological support for the decision on whether or not to propose to list the species as threatened or endangered.”

I assume that there will be copy-editing for minor corrections to the wording, but, at the end of this review, I list a number of typos and minor edits to consider.

My major comments are the following:

Line 66: You say, “The primary factors impacting the viability of Pecos pupfish are related to habitat: the loss and decline of water quantity, and the degradation of water quality.”

I would modify as follows: “The primary abiotic factors impacting viability of Pecos pupfish are (1) the loss and decline of surface-waters and (2) degradation of water quality. The primary biotic factor is hybridization with and genetic introgression by the introduced Sheepshead Minnow.”

Line 327: change “Pecos River” to “Pecos River Basin” because Leon Springs is not in the Pecos River.

Line 329: You say, “until an extant population of Leon Springs pupfish was found at Leon Springs, Pecos County, Texas . . .”

Change to read “. . . was found in Diamond Y Draw, Pecos County, Texas . . .”

Explanation: The extant population occurs in Diamond Y Draw. Leon Creek, which includes the now dry Leon Springs, is a tributary of Diamond Y Draw.

Line 334: Change “Cyprinodon phylogenetic relationships” to “relationships of Pecos pupfish.”

Line 354: You say, “On Bitter Lake NWR two distinct clusters were observed that may indicated gene flow.”

Change underlined to read, “that likely reflects restricted gene flow.”

Line 395: Doege 2023—Not in Literature Cited

Line 404: Table 1: For egg requirements delete, “Topographic diversity with silty substrate to adhere to.” Pupfish avoid silt for spawning. In silt-laden situations, they prefer hard substrates.

Line 408: You say, “As with most pupfish, the Pecos pupfish requires a silty substrate, water depths less than two meters (m) 410 deep, and areas with topographic diversity for spawning (Kodric-Brown 1977, pp. 750–751).”

I don’t think pupfish “require” silty substrate for spawning or anything else, and my reading of the cited pages in Kodric-Brown (1977) does not say this.

You might reword to read “. . . often occurs in quiet waters less than two meters . . .”

Line 897: Add the following to end of paragraph:

“Childs et al. (1996) speculated that the spread of hybrid Pecos pupfish x Sheepshead minnow in Salt Creek upstream from its mouth occurred during a period when abundance of the native Pecos pupfish was low, possibly because of an undocumented fish kill caused by an algal bloom.”

Line 923: I suggest replacing the paragraph beginning on this line with the following:

“The effect of predation by other fishes, birds, etc. on Pecos pupfish populations is unknown. However, hybrid Pecos pupfish x Sheepshead minnow are a primary dietary item for the non-native gulf killifish (*Fundulus grandis*) in the lower Pecos (East et al. 2017). Also, elsewhere in

the Southwest, predation by non-native fishes is implicated in the decline of Desert pupfish (*C. macularius*) (Schoenherr 1981) and the extinction of Monkey spring pupfish (*C. arcuatus*) (Minckley et al. 2002).”

East, J. L., C. Wilcut, and A. A. Pease. 2017. Aquatic food-web structure along a salinized dryland river. *Freshwater Biology* 62:681-694.

Minckley, W. L., R. R. Miller, and S. M. Norris. 2002. Three new Pupfish species, *Cyprinodon* (Teleostei, Cyprinodontidae), from Chihuahua, Mexico, and Arizona, USA. *Copeia* 2002:687-705.

Schoenherr, A. A. 1981. The role of competition in the displacement of native fishes by introduced species, p. 173-203. *In: Fishes in North American deserts*. R. J. Naiman and D. L. Soltz (eds.). Wiley, NY.

Line 942: You say, “Overall, the introgression of the sheepshead minnow coupled with one or all of these stressors will greatly reduce the viability of the species.”

I suggest changing underlined wording to read, “introgression by sheepshead minnow alone or coupled with.”

Line 1162: You say, “However, at salinities greater than 35,000 1163 mg/L, larval and egg development are suppressed (Kinne and Kinne 1962)

After “suppressed” add “in Desert pupfish, *Cyprinodon macularius*”

Otherwise, it sounds like this is known specifically for Pecos pupfish.

Line 1451: You say, “suggest that Pecos pupfish morphology differs depending on the environmental setting”

Follow “setting” with, “, a result that might reflect either developmental plasticity or local genetic adaptation.”

Line 1497: You say, “Given these factors, we think the most important future influences on Pecos pupfish viability will result from potential changes in water availability.”

I suggest changing “future influences on” to read “abiotic factors affecting.” Then add the following as a new sentence: “The most important biotic factor is the potential for hybridization and genetic introgression by Sheepshead minnow.”

MINOR TYPOS, ETC.

Line 267: delete “10”

Line 276: replace “the candy darter” with “the Pecos pupfish”

Line 322: change "to" to "to be" [or just delete the "to."]

Line 444: “be reflective [of] habitat” [insert “of”]

Line 475: Typos (underlined), “Pecos pupfish prefer environments with little to know water flow, and, in areas with flows, the typically occupy polls . . .”

change to “no,” “they,” and “pools.”

Line 528: After “County,” insert “Texas.”

Line 582: You say, “These are events that are reasonably likely to occur, however, occur infrequently enough that they can drastically alter the ecosystem where they happen.”

This needs rewording—how about? “These events occur frequently enough that they can drastically alter local ecosystems.”

Line 714: Change “move” to “dispersal”

Line 759: Change “Conor” to “Connor”

Line 811: Karst aquifer systems, . . . may affect sinkhole systems. However, to the degree is poorly understood as effective study requires more techniques . . . .”

Delete “to.” Also, this seems to need rewriting (or deletion). I don’t see how karst systems could do anything other than “affect sinkhole systems,” because without the karst system the sinkhole system would not exist.

Line 819: change “rain fall” to “rainfall”

Line 829: change “sensitive for” to “susceptible to?”

Line 841: delete “extremely high”

Line 849: change “included” to “include”

Line 873: change “complete” to “completely”

Line 877: change “fish” to “fish kill”

Line 901: The two sentences starting here are a bit confusing.

The first says “reductions in phosphorus may also create unfavorable conditions . . .” To clarify, it seems that you should insert “for algal growth” after “conditions?”

The sentence that follows seems redundant. Delete?

Line 911: You say, “Intraspecific and interspecific competition is the stressor of available food resources.”

Change “the stressor of” to read “a stressor when there is a decline in”

Line 921: Change “spec.” (two places) to “spp.”

Line 1177: Change “surface” to “terrestrial”

Line 1186: Change “influence” to “influenced”

Line 1207: Change “in proximity” to “in close proximity”

Line 1234: Change “experience regular” to “regularly experience”

Line 1294: Change “any of a” to “a known”

Line 1324: Change “in” to “occurred in”

Line 1449: Delete “that data analyzed by”

Line 1471: Change “suggested” to “suggests”

Line 1473: decline [in] representation [insert “in”]

Line 1496: delete “future”