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VIA ELECTRONIC MAIL: NO HARD COPY TO FOLLOW
Memorandum

To: Wayne Pullan, Regional Director, Upper Colorado Basin, Bureau of Reclamation
Kathleen Callister, LTEMP SEIS Project Manager, Bureau of Reclamation
Bill Stewart, Adaptive Management Group Chief, Bureau of Reclamation

From: Kate Hammond, Regional Director
Department of Interior Regions 6, 7, & 8
National Park Service

Subject: National Park Service Comments on the Bureau of Reclamation February 2024 "Supplemental Environmental Impact Statement for the December 2016 Record of Decision Entitled Glen Canyon Dam Long-Term Experimental and Management Plan"

The National Park Service (NPS) appreciates the opportunity to provide input on the February 2024 Public Draft of the "Supplemental Environmental Impact Statement for the December 2016 Record of Decision Entitled Glen Canyon Dam Long-Term Experimental and Management Plan" (LTEMP/SEIS) prepared by the Bureau of Reclamation (Reclamation). As a cooperating agency pursuant to the National Environmental Policy Act (NEPA), NPS also appreciates the opportunity to provide special expertise and comments on previous drafts and to provide further input on this draft SEIS. NPS provides the following comments:

Urgency and Timeline:

- NPS hopes that this process can stay on track and that Reclamation chooses the most effective alternative to comply with the 1992 Grand Canyon Protection Act (GCPA) to prevent irreversible and detrimental impacts to the native fish populations, the federally threatened humpback chub and the federally endangered razorback sucker within Grand Canyon National Park. We commend these efforts to expedite and prioritize this planning process despite the many other planning priorities in the Colorado River ecosystem.

- Completing this process by late spring 2024 is imperative to prevent Smallmouth Bass (SMB) establishment below the Glen Canyon Dam (GCD) on national park units, and to protect native and federally listed fish, (humpback chub and razorback sucker), on park units when river temperatures increase in the summer. NPS agrees that Reclamation should act with urgency, using the most effective bypass alternatives in June 2024 to mitigate invading populations close to GCD. NPS has been advised by U.S. Fish and Wildlife Service (USFWS) fisheries experts in the Upper Colorado River Basin, who have been working to control SMB populations for over 20 years and watching the impact of this predator on native fish and amphibians in higher turbidity waters, that agencies should not delay action and should instead act with the most

effective tools by this summer. A recent paper from a group of researchers who work in the upper basin stated:

- *There is substantial overlap in the thermal suitability of river segments for growth of warmwater native and nonnative fishes across the basin, and current evidence suggests nonnative species have a competitive or predatory advantage over native species in places where their ranges overlap (Olden et al. 2006, Johnson et al. 2008). Our analysis demonstrates that nonnative species in the basin have responded more strongly to recent river warming than native species. Thus, in the absence of effective management interventions, future warming is likely to disproportionately benefit nonnative species to the detriment of native species (Dibble et. al 2020).*

- Currently, this SEIS states that SMB operations would end in 2027. That is assuming that other approaches such as a thermal curtain may be available and effective by then. However, given uncertainties, NPS recommends extending the timeframe for the SMB operations beyond 2027 through the lifetime of the original LTEMP, in case other tools (temperature curtain or higher Powell elevation) are not available or prove ineffective by 2027. If that happens, and if the elevation of Lake Powell falls lower and release temperatures return to over 15.5C, these bypass flow tools would need to be continued to address the mandates of the GCPA and the Endangered Species Act (ESA).

Non-Bypass Alternative:

- NPS believes the Non-Bypass alternative does not meet the purpose and need of the SEIS based on the 2022 evaluation of the USFWS-led multiagency SMB Task Force, the subsequent analysis performed in the development of the Reclamation SMB Environmental Assessment (EA), and the modeling analysis presented in this LTEMP SEIS document. The need for the SEIS is "*…to disrupt the establishment of smallmouth bass below Glen Canyon Dam by limiting additional recruitment, which could threaten populations of threatened humpback chub below the dam";* however, based on SMB population growth modeling (lambda), the Non-Bypass alternative is not effective. The purpose of the plan is to prevent the SMB population from growing and expanding during summers when dam release water temperatures are over 15.5C. A lambda less than 1.0 would indicate the alternative is creating conditions for the SMB population to decline whereas a lambda greater than one indicates the alternative is failing to prevent the growth of the population. This Non-Bypass alternative fails to achieve a lambda less than 1 in warmer water summers and instead shows growth of the population with a lambda factor of about 1.5-2.0. The current analysis in the plan lumps all the results together for both warm and colder water summers, but when these results are split out, it is clear this alternative does not perform significantly different from no action, which also fails to stop the SMB from reproducing. Reclamation has evidence in this SEIS for dismissal of this alternative as it does not meet the published purpose and need.

- Concern regarding significant impacts to downstream resources and recreation. This analysis shows that the Non-Bypass tool may have many impacts that would make it incompatible with the GCPA's mandate to protect, mitigate adverse effects to, and improve the natural and cultural resources and recreation below the GCD. The Non-Bypass alternative would have significant fluctuations from 2,000 cfs up to 27,000 cfs occurring on a weekly basis, potentially for up to 26 times throughout the summer. Given the extent of impacts to downstream resources below, we believe implementing Non-Bypass flows would not be consistent with the intent of the GCPA due to the following:

- Sediment impacts: When the effects of the Non-Bypass alternative are split out for those months or years in which the Non-Bypass tool is actually used, they show increased sand mass balance and beach erosion and decreases in the frequency of High Flow Experiments (HFEs). These effects will decrease the natural aeolian transport processes in the canyon, threaten the protection of archeological sites, and reduce the area of recreational camping beaches, while also directly impacting the rafting recreation with flows lower than what are currently allowed under the 2016 LTEMP EIS.
- Recreation impacts: While the plan currently mentions some impact to recreation from the non-bypass flows, it fails to articulate that these flows might occur on a weekly basis. For guided boating in the Glen Canyon National Recreation Area (NRA), this would likely mean shutting down concessions during those days. While that is similar to the impacts of an HFE, an HFE occurs once a year, whereas these may occur more than 20 times a summer, which is a more significant impact.
- Impacts to Native Amphibians and invertebrates: The current analysis fails to mention impacts to native amphibians. In locations such as the river mile-12 slough, we may already be seeing SMB prey upon native salamanders and other amphibians and invertebrates, and based on research in other river systems where SMB have invaded, these impacts would be likely to increase throughout the system below the dam if alternatives fail to prevent the establishment of SMB (Sanderson et al. 2009, Kiesecker and Blaustein 1998, Hayes and Jennings 1986; Dill and Cordone 1997).
- Food base and direct Native Fish Impacts: According to the SEIS routing chart, these frequent and large river fluctuations under the non-bypass alternative persist down to the Little Colorado River (LCR) and beyond, and may result in desiccation of macroinvertebrate resources, ultimately impacting food base in the system. These significant fluctuations during the summer through Marble Canyon would also be likely to impact native fish, including the humpback chub aggregation at river mile 30.
- Rainbow Trout Fishery Impacts: Non-bypass fluctuations are also likely to impact the rainbow trout fishery in Lees Ferry which is already at very low population levels and facing more stressors than it ever has. This alternative fails to prevent the low dissolved oxygen levels and elevated temperatures that occur in the worst 17-20% of the traces run in the modeling scenarios, which will increasingly stress the rainbow trout.
- Ineffective at preventing the establishment of SMB. This alternative also fails to reduce the growth and distribution of the warm water invasive fish populations that threaten native aquatic resources. These types of impacts are what led to the 1995 EIS that moved dam operations away from large daily fluctuations to comply with the GCPA. NPS encourages Reclamation to consider dismissal of this alternative given its inconsistency with the intent of the GCPA.

- Engineering constraints and remodeling: The Non-Bypass Alternative was designed with low flows down to 2,000 cfs. NPS understands there may be new potential operational restrictions of maintaining penstock flows of at least 3,000 cfs or perhaps even 3,500 cfs; If this alternative is not dismissed then it may require further analysis in the SEIS to show how those guidelines may affect the modeled lambdas.

Further Hydropower Analysis:

- Bypass alternatives have reasonably low impact levels to hydropower: This document includes hydropower value loss estimates that indicate a wide range in fiscal impacts depending on the annual conditions, which include reservoir elevation, temperature profile and the distance down

the river that is chosen for the cooling effect based on the distribution of SMB. This analysis shows that the maximum impacts from the bypass alternatives would result in about 1-2% of hydropower value reduction or about $10-16M. For a measure that may be needed to prevent the loss of the native fish species in the Grand Canyon and protect the federally threatened humpback chub, this suggests that these bypass alternatives are viable approaches that would have minimal value loss and would be consistent with the GCPA mandate to operate the dam in a manner to protect, mitigate the adverse effects to, and improve the natural and cultural resources and recreation downstream of GCD.

- Hydropower modeling transparency: NPS understands that much of the hydropower modeling in this document was performed by the Grand Canyon Monitoring and Research Center (GCMRC). The assumptions and methods appear very clear and transparent, but there has been substantial criticism of this work from hydropower interests. NPS understands that much of this controversy is because GCMRC adjusted future energy costs to be more realistic. The Argus Forward Mid-Market projections for the Palo Verde hub are used by Western Area Power Administration (WAPA) and were also used by GCMRC, but because these projections include a risk premium, these were adjusted to be more representative of the marginal cost of energy by GCMRC using actual prices from February 2000 through November 2023 and the Argus Forward Mid-Market projections. NPS encourages Reclamation to continue to use these estimates from GCMRC to ensure that cost impacts to hydropower are fairly and objectively estimated. NPS understands WAPA will be submitting another cost estimate during this comment process using a different method, and hope this estimate is provided with sufficient time for review and with a clear and transparent set of assumptions, that it is peer reviewed to ensure objectivity, and can be weighed in relation these estimates from GCMRC. To be objective information for this SEIS, we hope any new analysis includes similar adjustments to the GMCRC analysis to be more representative of the marginal cost of energy using methods to correct the Argus Forward Mid-Market projections.

Support for HFE Protocol Adjustments:

- HFE adjustments will retain the original intent of the LTEMP and comply with the GCPA: NPS supports and appreciates the adjustments that Reclamation is making to the HFE Protocol in this SEIS. These changes will help allow for HFEs to be implemented with a frequency close to what was intended in the original LTEMP EIS even when water levels are lower. These changes will also shift the HFEs to more natural timing with more occurring between April and June under certain circumstance which is closer the historic timing of peak flows and more likely to be beneficial to the native species that evolved in this system. NPS appreciates Reclamation's commitment to the intent of the GCPA and to following through on the recommendations from GCMRC and the Flow Ad hoc group of the Adaptive Management Work Group (AMWG).

Consideration of a Combined Alternative:

- Possible combination of alternative options: NPS understands that, due to discussions occurring, it may make sense to combine a suite of alternatives into an umbrella or menu-oriented alternative where a particular option could be chosen to fit the conditions of a specific year. NPS is not opposed to this approach as it may increase flexibility; however, we would strongly suggest that only tools that are able to meet the purpose and need of discontinuing the establishment of SMB are combined into an umbrella alternative. This would include the 4 alternatives that use bypass. If tools do not reduce lambda below 1, then they are not effective and should not be considered at this point in the invasion curve. The Non-Bypass alternative,

when lambda results are averaged for the months or years when the tool is actually needed and used (when release temperatures are greater than 15.5C) does not reduce lambda below 1, so it does not in fact *disrupt the establishment of smallmouth bass*. For this reason, this alternative should not be included. It is critical, particularly in the summer of 2024, to use the most effective tools available while SMB is still limited in distribution to Lees Ferry and the most eastern portion of Marble Canyon. Many of these tools will be less effective if the population expands during this early phase in the invasion curve. NPS recommends prioritizing the use of tools that will be the most effective the earliest in the process based on the lambda values. If there is the possibility that Reclamation may not choose to use the most effective tool during the first year (2024), then this SEIS should include a cost analysis of how much more bypass cooling might cost in the 2nd year (2025) if SMB distribution expands further downriver.

Below are additional technical comments on how NPS recommends that data be organized and specific areas where additional citations or analysis is needed:

Averaging problem in the analysis of the modeling

- Not all resources are being compared the same way and this may cause inconsistent comparisons that underestimate the impacts of some alternatives on some resources. NPS' understanding of the modeling is that there were 30 traces used; approximately 6 of the traces had years where release temperatures were greater than 15.5C and about 24 traces where temperatures stayed below 15.5C. Resources were analyzed to look at the effects of the alternative as averaged over all traces. Since the alternatives have tools that are only used in months where the temperature exceeds 15.5C, averaging across all the traces means we are averaging out the actual effects with 83% of the runs that didn't use the tool. That would mean we are only really seeing about 1/5 of the impact, rather than the actual impact that would be experienced if the future was actually a trace where release temperature was hotter. In years where these tools aren't needed, the costs and impacts of the tools is zero because this would be no action. For hydropower, the analysis broke out the effects for the months where the tools were used to show the real impact of use of those tools in Table 3-26. NPS believes this to be the correct way to look at all impacts. In comparison, this same type of table should be used to assess these impacts in the months or years when the tools are actually used:
    - Lambda for SMB population growth: this should be expressed in table form similar to 3-26, as an average lambda for the months in which the tools are used (when temp > 15.5C). This should be considered as months because even years that the tools are used may vary significantly if the tool is only used for one month vs. when it is used for 5 months; however, GCMRC may have reasons why they believe year might be more appropriate. In either circumstance, NPS would strongly suggest not doing this by trace, which would lump together 4 years when in fact the tool might only be used in one year of the four.
    - Frequency and Duration of HFEs: NPS recommends this be in table form, again broken out for the years when the tools are used only because in the years they aren't used, it would look and function exactly like no action. Currently, the way it is presented, it looks like there are no differences in HFEs amongst the alternatives, but NPS thinks that when this is split out clearly based on the years the tools are used, it will show some marked differences.
    - Sand Mass Balance and Beach Building metrics: both need to be split out for the months or at least the years in which the tools are used (temp>15.5C), which would show the full effects of the alternatives on these metrics. GCMRC may have to advise whether months or years would be more appropriate, and if years whether those should start and end July 1 because of the HFE accounting window.

- Dissolved Oxygen: NPS recommends this data and graph be broken out to show the effects to dissolved oxygen for the years in which the tools are used, otherwise this is mostly comparing the effects of no action to no action. NPS believes there will be a more distinct difference that will emerge on the alternatives with bypass cooling versus those without. Again, that is a fair way to compare similar to the hydropower table 3-26, because we don't actually experience the average of the traces in the future, rather, it is only the future trace that occurs.

Other modeling presentation issues

- Representative Summer-Long Releases for each Alternative: In chapter 2, NPS sees the need for a graph showing the alternative releases for the entire summer (May1-Oct 31) using a representative trace with higher release temperatures where the tools are used for most of the summer. Currently you are only showing a representative week, but there are important differences with frequencies and timing of these flows throughout the summer. For the alternatives with flow spikes that would show the 3 spikes occurring from June to mid-July. For the Non-Bypass our understanding is that might show 26 fluctuations between May to October. We think that it is not clear to most readers how frequent these flows might be occurring in a hot summer. The graphs in 3.2.1 appear to show monthly volumes over time, but not the actual spikes.
- Lambda graphic: Currently, this graphic is in an appendix and since it is the most important modeling result it should be moved to the main text. It needs some reformatting as its very confusing. The labels should be moved below the axis, the thick lines where most of the results are falling needs a tick off to the side (is it 90%, 92%, 95%?) and should be a dot rather than a line like the other locations. Again, this graphic would be much more useful if it showed only the traces in which temperature exceeds 15.5C as those are the traces in which the tools are used. Also as suggested above, a table format presentation with the breakout for the months where 15.5 was exceeded with average lambda values would be even more useful.
- Trace graphs to accompany lambda graph: Another two graphs that would be very useful to be presented in the same section accompanying the lambda values would one with the Lake Powell elevation over years and one with the release temperature over years showing all 30 traces. This would illustrate how many traces did not exceed 15.5C and explain why based on reservoir levels. That is an important part to relay. Again, current graphs in section 3.2.1 appear to show the averaging of all the traces for temperature and lake Powell elevation but seeing the 30 individual traces and seeing them right next to the lambda graph would be much more useful for comprehension of what is happening.
- Improved Routing map in Figure 2-6: This routing map for the Non-Bypass should be relabeled as the term "collapsing trough" is a bit subjective. We actually don't see the trough collapsing by the LCR, it appears to still be a trough at that point. It would be helpful to have stage on the right axis (we think that was intended but it shows as all zeros on the right axis) and a gridded and more clear set of labels and tics on the left-hand axis so we can tell what the minimum flows actually are at the LCR. On the X axis it would be helpful to have time, because one of the assertions of the Non-Bypass alternative is that it won't desiccate invertebrates because its dropping at night but as that wave propagates down it won't be at night but may be in direct sunlight in august daytime temperatures.
- Sediment graphics showing HFEs: NPS recommends breaking these out to show representative trace years in which fall season HFEs occurred vs. those with spring HFEs, as well as for those in which other tools were used (the flow spikes vs. Non-Bypass fluctuations vs. those without any). Currently, these graphics are misleading both in terms of the averaging problem (stated

above) but also it makes it looks like there will be two HFEs a year. This may create concerns for some stakeholders thinking that HFE frequency is increasing when in fact the frequency may decrease slightly from the original LTEMP using the modeling assumptions. We suspect if this is broken out, the frequency of HFEs would decrease the most under Non-Bypass in the years when that tool is used.

Issues in need of more updated references or additional analysis considerations

- Fully incorporating the implications of the lambda results
    - In both Table 2.12 (impact summary table) and section 3.5 (aquatic resources) the lambda modeling results treated separately and almost as if they are an unrelated issue with respect to effects of the alternatives to native and non-native fish. Those results are the best available science for whether the alternative actually meets the purpose and need to either: (1) control the growth and expansion of the warmwater invasive fish populations or not, and (2) minimize impacts of predation on native fish populations or not. Those results are not fully interpreted when they are presented and aren't carried through into the subsections to relay the potential impacts of the alternatives in comparison to no action and each other. For example, the lambda results show that cool mix is keeping lambda well under 1.0 in the warmest years, whereas no action has lambdas well over 1.0 or even over 2.0 in those warmest years. NPS recommends this be interpreted to explain that these results indicate smallmouth bass and other warmwater invasive populations would decline under "Coolmix" and native fish would then not face increasing predation, whereas under no action, smallmouth bass and other warmwater invasive populations would increase and possibly double each year. After a time delay, native fish would be subject to an expanding wave of predation from these fish that would likely impact them at the population level. The most important place to fully incorporate these results is on pages 3-133 and 3-134 for the effects of Non-Bypass alternatives in terms of how SMB and GSF populations would expand and impact HBC and RBS under no action and Non-Bypass.
- Updating non-native information from 2018-2024 in section 3.5
    - Much of the non-native presence and distribution information is cited before 2018. Given the increased river temperatures and presumed entrainment in the last few years, NPS recommends inclusion of literature from 2018-2024 including information presented at the GCMRC Annual Review Meetings. NPS can supply an appendix to the 2019 NPS Expanded Aquatic Non-native Species Management Plan to help, and the Annual Review Meeting (ARM) information should be readily available from GMCRC. GCMRC can also provide access to a shared non-native database and new mapping information for the distributions of non-native fish that should be used in this document, particularly for smallmouth bass, green sunfish, walleye and brown trout. NPS will provide a presentation from the last AMWG that summarizes much of that data and provides details of NPS' rapid response efforts.

- Food base implications from Non-Bypass alternative
    - The food base impacts in the plan need improvement and input from GCMRC. The plan currently seems to conclude the Non-Bypass fluctuations from 2000 cfs to 27000 cfs that might occur every week throughout the summer for over 20 times a summer would have little to no impact on food base. These findings are inconsistent with findings of the effects from past HFEs or from past "bugflows" where altered flows, even when occurring only once a year, have shown marked impacts that were positive or negative

to macroinvertebrates or gross primary production (GPP). The plan states that these Non-Bypass flows wouldn't desiccate macroinvertebrates because they are short and at night, citing Blinn 1999. Blinn 1999, looked at effects in early spring from the 1996 Beach Building Flow when temperatures at night were much lower and the frequency of the flow was only once that year. These Non-Bypass flows would occur repeatedly throughout the summer up to over 20 times during much hotter months. Also, the fluctuations do not collapse much by the LCR, so the fluctuation would propagate through Marble Canyon during the day, which would be in hot temperatures in direct sunlight. There may also be some impacts to macroinvertebrates and the food base from the flow spikes or from spring HFEs; however, the frequency of those spikes is limited to 3 per year, they don't involve the drop before the increase, and the timing of those corresponds well with natural pre-dam spring peak flows and that should be noted in the plan. Given the preponderance of studies that indicate natural timed flows are better for many organisms that evolved with that timing (see Poff et al 1997, Poff and Matthews 2013, etc.), NPS requests analysis in the SEIS of timing of flows in relation to natural and historical flow regime.

- <u>Rainbow trout population effects from Non-Bypass alternative</u>
    - Several sections of the plan conclude that rainbow trout population would not likely be affected by the Non-Bypass fluctuations despite expected increased mortality in young rainbow trout. The conclusion appears to be based primarily on the Korman 2011 study that found compensatory responses to flows that impact rainbow trout reproduction. However, the current rainbow trout population is at a much lower population than any of the data points that Korman 2011 considered with fewer total reproducing fish. There are also major stressors on the population, including occasional high river temperatures (which vary with alternative), low dissolved oxygen situations (which vary with alternative), increased brown trout predation and competition, and the potential for significantly increased predation from warm water predators (which varies with alternative). Also, the health of the trout population is a recent concern this spring (2024), which may have to do with some impacts from these stressors. NPS recommends these factors be taken into consideration, as assuming a compensatory response no longer seems like a reliable conclusion.

NPS appreciates the close coordination between the agencies within the Department of the Interior. This collaboration has been exceptional and NPS appreciates Reclamation's staff's efforts to integrate the best available science into this analysis and continued coordination for SMB response. Reclamation has truly risen to the challenge presented by these rapidly changing conditions.

Thank you for the opportunity to comment on this important and expedited process. Please contact Rob Billerbeck, NPS Colorado River Program Coordinator, at 303-987-6789 or rob_p_billerbeck@nps.gov if you have any questions on these comments or wish to discuss further.

Kate Hammond
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Cc:
Rob Billerbeck, Colorado River Coordinator, National Park Service, DOI Regions 6, 7, & 8
Ed Keable, Superintendent Grand Canyon National Park
Michelle Kerns, Superintendent Glen Canyon National Recreation Area

Enclosure 1: NPS Technical Comment Matrix

Literature Cited

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Sanderson BL, Barnas KA, Wargo Rub AM (2009) Nonindigenous species of the Pacific Northwest: An overlooked risk to endangered salmon? BioScience 59(3): 245–256, http://dx.doi.org/10.1525/bio.2009.59.3.9

LTEMP SEIS

NPS comments - yellow high importance comments we feel strongly need to be addressed, the reddishbrown are the very high importance, most

Cmt #	Section #	Line # / Table #	Page Number	Agency	Commenter	Comment	Response (reviewers leave blank)
	1.1		1	NPS	J Balsom	In the opening section, please edit to recognize that the Colorado River meanders through many more rocks types than sandstone. The river cuts through sandstone cliffs in the 15 miles below Glen Canyon Dam, and quickly downcuts through the entirety of the Grand Canyon strata, from limestone through schist and granite.	
	1.1		1	NPS	J Balsom	2nd paragraph .... Reclamation and NPS, not just Reclamation, developed LTEMP. It is correct in the 4th paragraph but not the 2nd.	
	1.2		1-4	NPS	J Balsom	2nd complete paragraph references LTEMP FEIS also includes a proposal … Should this not reference the current SEIS?	
	1.5		1-6	NPS	J Balsom	end of page, NPS is the only agency not spelled out with abbreviation in ( )	
	1.5		1-7	NPS	J Balsom	Under the "NPS administers" paragraph, delete Baaj Nwaajjo l'tah Grand canyon National Monument. BLM and FS administer those areas	
	2.3		2-2	NPS	R Billerbeck	Strike the extra 'the' - This document provides detailed changes to the both the sediment account period and implementation window.	
	2.5		2-10	NPS	R Billerbeck	Could add at the bottom that SMB are also likely to prey upon the rainbow trout and impact the rainbow trout fishery.	
	2.1		2-17 and 2-18	NPS	M Trammell	First para in section 2.10 states that 'The design of this alternative is such that the short-duration, low-flow and high-flow releases are largely attenuated by the time the flow wave reaches the confluence with the Little Colorado River." but in para 2 on page 2-18 it says 'The fluctuations shown in Figure 2-5 were designed to disrupt the smallmouth bass spawning at river mile 61.' If the flows dissipate by the LCR, they can't also be designed to disrupt spawning in the same location (RM61). Also, as stated in following comment, the trough is not in fact attenuated by the time the flow wave reaches the LCR (RM 61). Please delete the first quoted sentence above.	
	2-10	figure 2-6	2-19	NPS	R Billerbeck	The axis titles on the figure 2-6 are too small to read, and the right axis is probably supposed to be stage but says all 0's. Objectively, this figure does NOT show the fluctual trough dissipating by the LCR. WAPA has been saying it would 'collapse' by the time the trough reaches the LCR ('collapse is in the title of the figure) but this figure appears to show there is still a large variation in flow at the LCR, and even at Pumpkin Springs, and flows are still dropping below 5000cfs at the LCR. The amount of time flows are below 5000 cfs is shown as shorter, but it is impossible to tell how long from this figure. The scale should be better with a higher resolution, so you can actually read the graph. Also we can't tell time of day the trough reaches the LCR or Pumpkin Springs, and that is important to how the flows impact macroinverts, as impacts are higher during daylight hours especially in summer heat. please add a figure that shows only a two-day time period or add a table to show what hour of day the trough is low.	

	2.12	table 2-1	2-20, 2-21	NPS	R Billerbeck	important effects to GCPA resources and LTEMP goal effects. For no action - should restate as stated in the intro that HFEs are likely to happen at a lower frequency than was estimated in the LTEMP if we remain in lower water conditions under no action. Should also state the warmer river and dissolved oxygen are likely to negatively impact the rainbow trout fishery (this is stated elsewhere in the plan multiple times). For the non-bypass alternative it should state that it may have negative impacts on native fish because of the spread of warm water non-natives (because lambda results are very simliar to no action and that is the conclusion for no action). Also see new GCMRC report (to be released soon) and presentation (Yackulic, C.B., Bair, L.S., Eppehimer, D.E., Salter, G.L., Butterfield, B.J., Caster, J.J., Deemer, B.R., Fairley, H., Grams, P.E., Kasprak, A., Palmquist, E.C., and Sankey, J.B., 2024, Modeling the impacts of Glen Canyon Dam operations on Colorado River resources [presentation], LTEMP SEIS meeting (virtual), January 31, 2024: Flagstaff, Ariz., US Geological Survey, Southwest Biological Science Center, Grand Canyon Monitoring and Research Center, https://www.usgs.gov/centers/southwest-biological-science-center/science/modeling-impacts-glen-canyon-dam-operations), because we expect there would be impacts to								
	2.13	table 2-2	2-25	NPS	R Billerbeck	this summary for comparision and please split them out for the average of the runs where the tools were actually employed versus the runs where the tools were not used because currently the lumped average results are obscuring the effects of the flow spikes (max of 3) and the non-bypass fluctuations (every weekend so as many as 26) so we aren't really seeing the effects to the sediment that we are certain are there in the years when the tool is used. Hydropower has quantiative results sumarized here split out finely to understand the impacts and that is needed here for sand mass balance, the amt of sediment deposited and the frequency and duration of HFEs were all modeled - please report all those stats here for comparison. This is critically important. The effects of no-bypass alterantive for cultural resources and sediment fail to include the effect of the large fluctuations themselves. It appears that no-bypass may have a lower number of HFEs in the runs when it is actually employeed, but that difference is being lost when averaged over all 30 runs many of which don't use the tool. Also for the Sandbar Model results (figrue 3-22) you fail to disclose a very important aspect of that for the alts with flow spikes and for the non-bypass that these results are limited to only showing building but not erosion using the Mueller model. So these results must be interpreted in that								
	2.13	table 2-2	2-25	NPS	R Billerbeck	Please include the lambda statistic in this summary - it is critical for quantitive comparision and currently you are only reporting quantiative model results for hydropower - you need to do so for this - very important edit. The effects of the no-bypass alternative for aquatic resource suggest that alternative is effective for SMB reduction, but this summary should include the lambda and state that its effecitveness is not significantly different from no action but is significantly different from the bypass alternatives. This is a critical update to this table. Otherwise decision makers will not understand that this alternative actually fails to reduce the SMB population and merely slows population growth. That does apear to be the case - its not any more effective than no action, so this summary is currently very misleading. Please include lambda results in this table, and in the affected environment section (not just the appendix) and interpret them with statistical signficance. Please see all the edits and refrences below to suppport this and then come back to these summaries and edit them to fully reflect the information in chap 3 after those revisions.								

	2.13	table 2-2	2-26	NPS	R Billerbeck	indicate little impact to native fish and don't mention food base. Large fluctuations every weekend (up to 26 total compared to a max of 3 for flow spikes) would continue down to the LCR and even down to Pumpkin Springs with little amelioration according to Figure 2-6, so within GRCA that impacts locations like the 30 mile aggregation of HBC and native fish in Marble canyon. If the fluctations are in late spring or early summer they could impact recruitment or survival of yoy for native fish or HBC. They may also negatively impact GPP and macroinvertebrates. This also fails to state the biggest impact to native fish that is stated in the no action - that the SMB will prey upon them - if this no-bypass alternative has close to the same lambda values as no action (with lambda above 1 in most years), then the effects of increasing warmwater non-natives should also be the same and so that is critical that that is stated here in the summary. This is currently stated in a way that suggests this language was written before the analysis in chp3 and the appendix was submitted based on what is intended in the design of this alternative, but it appears this table wasn't updated based on the performance of the modeling of lambda, which shows its doesn't accomplish the goal based on those lambda results - the lambda results show performance very comparable to no action - please update									
	2.13	table 2-2	2-26	NPS	R Billerbeck	The effects of no bypass alterantive for aquatic resources indicate little impact to rainbow trout and food base. Our undestanding is that large fluctions in the past created a large boom/bust cycle in rainbow trout and negatively impacted rainbow trout (korman et al 2011). Though some other studies have shown compensatory effects in rainbow trout to Spring HFEs and other disturbance flows, the nonbypass alternative would be increasing fluctuations now in a time when rainbow trout have a very low population size and are already stressed by warm river temperatures, low dissolved oxygen, increased predation from brown trout and (given alterantive is showing low effectiveness to control SMB), additional predation from SMB... so its likely that these combination of factors would increase risk that the popultion would not respond with sufficient compensatory effects to overcome the negative impacts from the non-bypass alternative. Please see all the edits and refrences below to suppport this and then come back to these summaries and edit them to fully reflect the information in chap 3 after those revisions.									
	2.13	table 2-2	2-26	NPS	R Billerbeck	For aquatic resources there is no discussion of aquatic parasites, yet page 3-78 points out that warmer temperatures are much more likely to increase proliferation of fish parasites, so that statement should be included for No Action and Non-Bypass alternatives in contrast to the bypass cooling alternatives.									
	2.13	table 2-2	2-26	NPS	M Trammell	special status species - northern leopard frog is not listed as endangered or threatened. it is a species of concern in Arizona (correctly identified elsewhere in the document)									

	2.13	table 2-2	2-27	NPS	R Billerbeck	reduce SMB so SMB is likely to reduce populations of northern leopard frog as they feed on tadpoles. no bypass alternative - this alternative reduces lambda compared to no-action but does not stop SMB population growth based on the lambda values, so under this alternative we would expect more impact to northern leopard frog from direct predation on tadpoles than from the other alternatives. We would direct you toward these references from Keisecker and Blaustein 2008 in conservation biology https://doi.org/10.1111/j.1523-1739.1998.97125.x The introduction of several species of nonnative predatory fish, including smallmouth bass (Micropterus dolomieu), may also contribute to population declines of ranid frogs (Hayes & Jennings 1986). Smallmouth bass are known to prey on larval amphibians, including red-legged frog larvae (Scott & Crossman 1973;Kruse & Francis 1977; J. M. K., personal observation). Historically, smallmouth bass were restricted to central and eastern North America, but they have since been introduced throughout western North America (Lee et al. 1980;Minckley & Deacon 1991). Predation by nonnative fish can have negative effects on native frog populations (Bradford 1989;Bradford et al. 1993). Furthermore, exotic fish may exert indirect effects by introducing pathogens that can be transmitted to amphibians (Blaustein et al. 1994b;Kiesecker &									
	2.13	table 2-2	2-27	NPS	R Billerbeck	tribal resources - no action alternative - because no action won't reduce SMB and other warmwater invasive reproduction, then there will have to be more rapid response mech and chemical treatment to try to address these populations, thus increasing fish mortality over time. no bypass alternative - because nonbypass won't effectively reduce SMB lambda less than 1, then SMB and other warmwater invasive populations will continue to expand and there will have to be more rapid response mech and chemical treatment to try to address these populations, thus increasing fish mortality over the cooling alternatives.								
	2.13	table 2-2	2-27	NPS	R Billerbeck	recreation no bypass alternative - non-bypass alternative - Currently this is missing the short term impacts to recreational camping in marble given large stage change during implementation days (will require moving boats on shore multiple times). Also doesn't address long term impacts to camping in Marble canyon from the sandbar/beach erosion and the reduced number of HFEs we would expect from loss of sandmass balance reducing chances of triggering HFEs when compared to other action alternatives. This also doesn't include longterm impacts to recreational rainbow trout fishery from the increased predation impacts from warm water predators we would expect given the lambda values we expect with this alterantive compared to other bypass action alternatives.								
	3.2.1		3-2	NPS	R Billerbeck	Please change the sentence "Monthly release volumes are based on anticipated power demands, forecasted inflows, and other factors such as storage equalization between Lake Powell and Lake Mead" to say, "Monthly release volumes are based on the monthly pattern of the 2016 LTEMP ROD which takes into account GCPA resource concerns and anticipated power demands, forecasted inflows, and other factors such as storage equalization between Lake Powell and Lake Mead". The monthly volumes ARE NOT based on only hydropower.								
	3.2.1		3-3	NPS	R Billerbeck	It says "Long-term and annual release volumes from Lake Powell are detailed in the LTEMP FEIS (Department 2016a)." but this may be misleading to readers as the LTEMP does not set annual releases - annual releases are determined under the 2007 Interim Guidelines and the LROC, not by LTEMP.								

	3.2.1		3-3	NPS	R Billerbeck	It says "Releases can also fluctuate beyond those scheduled in accordance with ROD section 1.2B (DOI 2016b)." please add these additional words "Releases can also fluctuate beyond those scheduled under certain allowed circumstances in accordance with ROD section 1.2B (DOI 2016b)."										
	3.2.2		3-3	NPS	R Billerbeck	Please accept the tracked change shown that left in the text for the tempertaure of 15.5 degrees Celsius not 15.6										
			3-14	NPS	R Billerbeck	This page states "*When the high flow is then later released, this slug of water is expect to overtake the low flow wave by the time it researches river mile 61…*" but that does not appear to be the case in figure 2-6. There is still a trough present at the LCR. Please edit this text as it doesn't appear correct and please state what the min and max will be based on that routing diagram when it gets to the LCR as well as what time of day it would be be hitting by the time it gets there. That would be important information grounded in the hydrology modeling. The current text is not grounded in the modeling and is incorrect.										
	3.2.2		3-16	NPS	M Trammell	under Cumulative Effects - sentence 2 - end of sentence 'Overall elevation changes in Lake Powell under the action alternatives are relatively minor, and water.' '...and water.' does not make sense, please correct.										
	3.2.2	table 3-12	3-16	NPS	R Billerbeck	The way the # of HFEs statistics have been compiled doesn't allow for a fair comparison to hydropower results. They should be tabulated for only the years in which the alternative tools were used - in the years when temperature was greater than 15.5 C. This was done in the hydropower section in table 3-25 and we need apples to apples comparison of effects when the alternative tools are actually used. Otherwise for alternatives like the non-bypass that are likely reducing the # of HFEs by eroding the sand mass balance in the 17% of the runs in which the tool is being used, we can't see that effect because its being averaged out with the 83% of runs in which the tool wasn't used and it was just no action operations. We strongly suspect when this is run it will show a markedly lower number of HFEs. If that is correct, then those statistics and this big impact of that alternative need to be included in that top summary table.										
	3.3.1		3-18, 3-19	NPS	R Billerbeck	Under the description of the Basin Fund it says it is used to support environmental and salinity funds - is this true as our understanding is that for the last 3 or 4 years WAPA has not transferred any money from the Basin Fund to environmental programs, and is unlikely to do so in the near future. Please correct if this is no longer true. Kathy Callister would know the most precise answer to this.										

	3.3.1		3-19	NPS	R Billerbeck	In this paragraph "By bypassing the electrical generators at Glen Canyon Dam, the experiment will reduce hydropower generation. Accordingly, WAPA will be required to purchase replacement power to fulfill its contractual obligations to customers. The experiment would markedly increase the amount of non-reimbursable costs drawn from the Basin Fund and returned to the Treasury." It is unclear which experiment is being referred to - I would replace the word 'experiment' which is both unclear and not applied to this document, with "bypass alternatives". Also the statement that it will markedly affect the basin fund is not true under many scenarios for the bypass alternatives - it is entirely dependent on the hydrologic conditions as to how much the affect would be, so this statement is inaccurate and needs to be changed because it would only be correct under more severe hydrologies. Please make this paragraph consistent with the statement later in the plan on p3-27 that says "The action alternatives would have financial impacts that would vary to a large extent based on reservoir elevation and temperature conditions, as well as which river mile is targeted for cooling, based on the distribution of smallmouth bass."									
	3.3.1		3-19	NPS	R Billerbeck	In the discussion of the Basin Fund it would be helpful to provide readers perspective that the biggest impact to the Basin Fund in recent years has NOT been from bypass operations but rather from the level of lake powell - the lower levels of powell have significantly impacted hydropower head and hydropwer production and revenue - please include a statement about this very improtant fact that provides perspective to the public. Also paragraph 5 implies that the basin fund is used to fund the GCDAMP, and Upper Colorado River Recovery Implementation Program - which it no longer funds, except for costs (and benefits) from experimental flows.									
	3.3.1		3-20	NPS	R Billerbeck	It says "WAPA will continue to operate under the emergency exception criteria, as stipulated under the 1996 ROD", but I thought the 2016 LTEMP ROD replaced the 1996 ROD and I think it restated the emergency exception criteria in the 2016 ROD (could be wrong, but you might want to doublecheck). I would guess Rod Smith would know the definitive answer on that.									
	3.3.2		3-21	NPS	R Billerbeck	Under Methodology for GMCRC, it might be important to explain how this methodology corrects for overestimation of future prices - this sounded from the AMWG Lucas Bair presentation like an important difference between this methodology and the WAPA methodology that might be important for readers to understand. Lucas Bair could provide exact language for that.									
	3.4.1		3-43	NPS	R Billerbeck	The reported durations of hfes are hard to put in context without a table that shows the avg duration of HFEs for both spring and fall HFEs - please provide that so we can completely compare.									

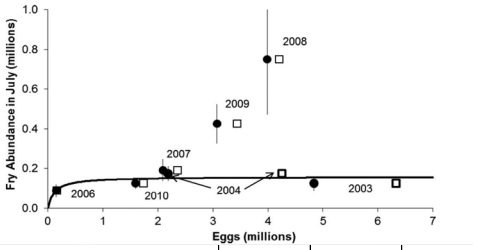
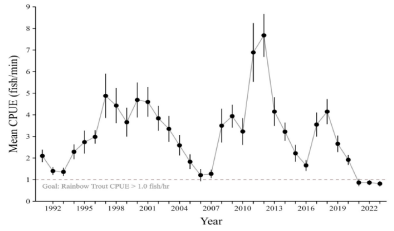
	3.4.1	figure 3-22	3-46	NPS	R Billerbeck	spike flows and the non-bypass alternative because they lump together results of 30 runs and show only an average. These need to broken out to show the sediment impacts in only the years when release temperature was over 15.5C and the tools were actually used. This would breakout make these results comparable to hydropower results in table 3-25. Without this its not a fair comparision. Averaging over all runs is problematic because we don't get to experience all of those futures - we may either have a future with lower reservoir elevations in which case the tools will be used more, or futures where the reservoir is higher and the tools aren't used. Those divergent futures will have very different results on the number of HFEs, the sand mass balance and the beach building and can't be lumped together without diluting those impacts. Also showing the results of these lumped situations in figures like 3-22 makes it appear that action action alternatives are doing twice as many HFEs as no action and that is not the case. That is greatly misleading and we need to separate out these graphs to that is more clear to readers. If this graph will be used, then it will need to be in addition to graphs that split out runs where the tools are used versus where they aren't used and to explain a great deal more in the legends. We request contrasting in one year each of these strategies for the total									
	3.4.1		3-47	NPS	R Billerbeck	Statements like this summary of the non-bypass alternative really need quantitative numbers to understand the differences - need % differences between alternatives for sand mass balance, for beach volumes and for # and durations of HFEs to be clearly reported in tables. Without stats its very difficult to interpret the level of differences... "Compared to other action alternatives, the Non-Bypass Alternative would cause the greatest reductions in mass balance starting in Spring 2025. This alternative would generally produce the second-smallest sandbars, slightly surpassing volumes that would be generated under alternatives without flow spikes." The differences need to then be relayed quantitatively in the summary table at the top of the document - this is very important. That is how it is being done for hydropwer and if we have quantitaitve results, that should also be done for fish and sediment results.									
	3.4.1		3-47	NPS	R Billerbeck	What does this mean - "Flow spikes that occur outside of the sediment accounting period would increase the likelihood of HFE deferral due to increased sediment export." Does this mean that flow spikes or nonpbyass flucturations happening after hfes in the spring windows (may-july) aren't accounted for because of the july 1 reset of sand mass balance? If so, we may be masking the loss of a lot of real sediment in each summer and that may be why we are seeing a lot less differences between alts with spikes and without or those with big fluctuations vs. those without. If this is the case we may need a true sand mass balance loss stat that is indepened of the sediment windows as a measure of what is being exported over the whole summer to compare between alternatives. And in the Summary seciton , we really need clearly quantitative results - for instance how much more sand mass balance was lost in a year where flow spikes or non-bypass flucutations were used when compared to coolmix or coldshock with no spikes. That would be a very useful number to see. How many HFEs of what duration were run with those same comparisons -we are quite confident there will be some clear differences if you make those explicit comparisions and show probabilities.									

	3.5.1		3-48	NPS	L.Tennant	Strike the 'and' and add a comma after backwaters - "along shorelines, ~~and~~ in backwaters, and tributary mouths. The aquatic food base for fishes also includes vertebrates, such as other fishes, which should be added to the first sentence under the "Aquatic Food Base" title.										
			3-54	NPS	L.Tennant	Differences in parasite density and abundance between the Little Colorado River and Colorado River are also caused by differences in salinity, not just temperature. The salinity in the LCR may actually work as a prophylactic for fishes. See Ward, D. L. (2012). Salinity of the Little Colorado River in Grand Canyon confers anti-parasitic properties on a native fish. Western North American Naturalist, 72(3), 334-338. Temperatures in the Colorado River (especially in the last few years) have allowed for parasites to complete their life cycles.										
			3-55	NPS	L.Tennant	Strike out 'two other native fish species' so the sentence should read, "In addittion, the flannelmouth sucker and bluhead sucker,....". When two other native fish species is mentioned, it sounds like two more native fishes other than what has been mentioned are goign to be mentioned in the senence. The word coexist in the last sentence prior to the figure,"....helps to explain why these species can coexist in a system...." makes me think that nonnative fish species and native fish species are inhabiting the same space peaceably. Consider changing the sentence to, "This figure illustrates the large overlap in temperature requirements of native and nonnative fish species found in the Colorado River and its tributaries, which may explain why nonnative and native fish species co-habitate a similar environment."										
		Figure 3-23	3-55	NPS	L.Tennant	Consider changing the figure title to "Optimal Temperature Ranges for Spawning, Egg Incubation,and Growth of Native and Nonnative Fishes of the the Colorado River System Below Glen Canyon Dam"										
			3-56	NPS	L.Tennant	Strike out "Of the remaining three species-" from the first sentence on page 3-56. Consider changing the sentence to, "The Zuni bluehead sucker, Little Colorado sucker, and Little Colorado spinedace are endemic to the upper reaches of the Little Colorado River. Change mainstream to mainstem in sentence, "....have been extirpated from the mainstream between....." Change all occurences of mainstream to mainstem when referring to the mainstem Colorado River.										
		Figure 3-29	3-56	NPS	L.Tennant	Razorback sucker have been found from Phantom Ranch to Pearce Ferry; might have to re-check accounts of speckled dace being captured as high up as Glen Canyon Dam, maybe from the Paria River downstream. Strike out 'with tributary fish being smaller' from sentence, "This species has been reported to be as large as..." since it was already mentioned that bluehead sucker may be smaller in tributaries. Strike out 'subspecies, as', from sentence "A related subspecies, the Zuni bluehead sucker, occurs in the headwaters of the Little Colorado River along with bluehead sucker that is the same ~~subspecies~~ species ~~as~~ in the mainstream Colorado River (AZGFD 2002a).										

			3-57	NPS	L.Tennant	Where is the supporting citation for this sentence? "Bluehead suckers are found more often in GCNP with warmer dam releases." Change capitalization of "Lower" to "lower Colorado River" in sentence, "relatively high numbers of individuals remain in the Lower Colorado River between Lava Falls Rapid (river mile 179) and Lake Mead". Where is more recent information from the larval fish studies (which occurs every year)? The data from this sentence, "Sampling of the larval fish community in the western Grand Canyon between Lava Falls and Pearce Ferry collected bluehead sucker larvae throughout the analysis area (Albrecht et al. 2014). In this analysis area, the bluehead sucker was the most abundant species in the larval fish community, composing almost 40 percent of the total catch." is ten years old now.									
			3-58	NPS	L.Tennant	This sentence, "Smaller tributaries may provide nursery grounds for populations of large adjacent rivers (Rinne and Magana 2002)." could use some clarity										
			3-59	NPS	L.Tennant	Add a comma after Paria Rivers in sentence, "Within the Grand Canyon, this species may be found in the mainstream Colorado River and its tributaries, including the Little Colorado and Paria Rivers, and Shinumo, Bright Angel, Kanab, and Havasu Creeks."										
			3-62	NPS	L.Tennant	~~Under Habitat: Strike this and replace with Speckled~~ In sentence, "~~This~~ Speckled dace spawns ~~s~~ twice, once in spring and again in late summer (AZGFD 2002b)" Under Factors Affecting....: This sentence, "Although this species is the most widely distributed and abundant native fish species in the Grand Canyon ecosystem, its abundance and distribution could be affected by many of the same factors that affect the abundance and distribution of the other native fish in the ecosystem, namely altered temperature, flow, and sediment regimes and predation by nonnative fish" needs to be reconsidered. Speckled Dace may not be the most widely distributed or abundant fish species any longer (e.g., flannelmouth sucker). Consider changing sentence to, "Speckled Dace abundance and distribution could be affected by many of the same factors that affect the abundance and distribution of the other native fish in the ecosystem, namely altered temperature, water flow, sediment regimes, and predation by nonnative fish." Under nonnative fish: The three species of fish mentioned in this sentence "Among these nonnative species, three are largely restricted to Lake Powell and/or Lake Mead and are found in the Colorado River and its tributaries below Glen Canyon Dam only occasionally; these species are black crappie, bluegill, and gizzard shad (Table 3-30)." are actually becoming increasingly more common to									
		Table 3-30	3-63	NPS	L.Tennant	Brown trout are incredibly abundant from Glen Canyon Dam to Lees Ferry; Channel catfish fairly abundant near and in Little Colorado River; Bluegill are becoming more abundant and captured in electrofishing surveys close to Glen Canyon Dam and from the dam to Badger Rapid in Grand Canyon; Largemouth bass individuals have been recently captured (2022) in Glen Canyon below the dam; Smallmouth bass found in increasing numbers in Glen Canyon from the dam to Marble Canyon. See R. Billerbeck's comment below please. Also, please add updated distribution maps or data tables from Katherine Tucker (BOR on detail to GCMRC) or from Melissa Trammell at NPS. This table is grossly outdated and misleading - sorry but you really need up to date info because so much has changed in the last few years. This is very important. should be a more effective way to do this broken into more relvant sections of the river.									
			3-64	NPS	R Billerbeck	There is a more recent compilation of non-native occurances in the appendix of the NPS Expanded Non-Native Aquatic Speces Management Plan EA										

			3-66	NPS	R Billerbeck										
			3-68	NPS	M Trammell	first para states SMB may have moved down the LIttle Colorado River, but recent conversations with FWS (David Ward) and Arizona Game and Fish (indicated there are no SMB in the LCR in Grand Canyon, and only one source in the drainage which is being actively addressed by removal, thus most most SMB originated either in Mead or entrained from Powell, until recent reproduction below the Glen Canyon Dam beginning in 2022									
			3-68	NPS	R Billerbeck	first para - "Starting in 2022, many of the bass are smaller, indicating that these fish have been produced locally, probably in and around the -12-mile slough." Is this conclusion correct or should it actually be qualified a bit to state that the majority of SMB may have been produced in the slough but many may have been entrained as young or spawned in other backwater areas including just below the dam… it seems like its very possible some were the result of entrainment of small individuals passing through the dam given findings upstream of the slough									
			3-68	NPS	R Billerbeck	This section really needs the graph of lamba from the appendix inserted directly into the text here - that is the most important data/modeling result in this plan and should be directly in the text given its importance for this decision as are the hydropower impacts. Also like hydropower we should have clear reporting of the statistics, not just a graph. Please add a table with the average lambda for all 30 runs for each alternative, and a % of runs for which the lambda is greater than 1. Those 2 statistics should be in there in a table and should also be ported up to the top summary.									
			3-69	NPS	M Trammell	Add a sentence on turbidity effects on predation of SMB on fish species. Although turbidity has been reported to reduce SMB feeding efficiency (Ward and Vaage 2019), evidence from the Upper Basin, which is perpetually turbid with values usually above 50 FNU and often above 1000 FNU, seems to indicate that SMB can survive and thrive at NTU/FNU regularly higher than 50 (125 JTU, approx), and have population level effects on native fishes (Bestgen and Hill 2016). Ward, D.L. and Vaage, B.M., 2019. What environmental conditions reduce predation vulnerability for juvenile Colorado River native fishes?. Journal of Fish and Wildlife Management, 10(1), pp.196-205.									

			3-72	NPS	R Billerbeck	The section on Rainbow trout seems to be outdated - only talks about daynamics to about 2018... its missing all the dyanmics and pressures that have been occuring in the last 2-3 years - increased river temperatures, decreased dissolved oxygen, increased predation/competitiion. These are important context for why the population is so low right now and related some of the alternatives that would be like to lower river temperature and improve the dissolved oxygen situation. Please see the presentations and graphs of rainbow trout from the GCMRC Annual Review Meeting proceedings from Jan 23-25 2024 to get the necessary updated info that shows the updated and very low population levels, the information about the low dissolved oxygen levels and the increased temperatures. Or if needed I'm sure Brian Healy and Josh Korman could provide the best data and references. This information is critically important as some of the alternatives like the non-bypass may reduce rainbow trout recruitment and the currently low population level and stressors may prevent a compensatory response so your text as well as your analytical conclusions need to be updated with the current population and dyanmics in Lees Ferry.									
			3-70, 74, 75	NPS	R Billerbeck	The sections on cold-water nonnative Species and brown trout seems to be outdated - only talks about dynamics to about 2015 in much of it with incorrect conslusions or up to 2018 with the Runge report. There is a lot of new info since then. For instance this statement "Because spawning by brown trout in the Grand Canyon occurs primarily in tributaries " is now totally incorrect. It may have been correct in 2014 but hasn't been correct since as we've documented a lot of spawning in Lees Ferry since 2015 - that whole paragraph needs to be updated with what we've seen from 2015-2024 with current population a graphs. Brown trout are no longer 'on the cusp' of recruiting locall hatched fish - they have recruited every year since 2016. Again - please see the presentations and graphs of rainbow trout and brown trout from the GCMRC Annual Review Meeting proceedings from Jan 23-25 2024 to get the necessary updated info that shows the updated and very low population levels of rainbows, the increasing number of browns and , the information about the low dissolved oxygen levels and the increased temperatures. Or if needed I'm sure Brian Healy and Josh Korman could provide the best data and references.									
			3-76	NPS	R Billerbeck	Table 3-31 is probably very outdated. Please get updated distribution maps for the LCR from GCMRC or FWS.									
			3-78	NPS	R Billerbeck	there are extra characters in this sentence - fix to say improved humpback growth and survival I think. For example, the temperature of water released from Glen Canyon Dam increased during the trout removal study period to temperatures that may have improve“ humpback c”ub growth and survival									
			3-79	NPS	M Trammell	please add a paragraph that interactions between native fish and increasing numbers of SMB and GSF are likely to increase, and that these native fish will be subjected to much higher predation levels from warm water non-native fish as they get established. Increases in smallmouth bass, green sunfish, walleye and others would be very likely to greatly reduce young native fish survival levels. There is abundant evidence from the upper colorado river basin, (Johnson et al. 2008, Bestgen and Hill 2016, Martinez et al. 2014 and other references), that should be stated here to discuss this interaction of smb impacting native fish.									

			3-78	NPS	R Billerbeck	Given that you draw the conclusion on 3-78 that ***" these warmer temperatures will likely provide more suitable conditions for the proliferation of a number of fish parasites that could negatively affect native fish species (see Figure 3-34)."*** Then why is isn't this important factor addressed in table 2-2. It should state that parasites are much more likely to increase under No Action and Non-Bypass than under the action alternatives that cool summer temperatures. Please be sure this significant aquatic resource issue gets included in the table 2-2.										
			3-79	NPS	R Billerbeck	affected significantly by fluctuating flows is much less likely to be true now. Rainbow trout recruitment is likely to be affected, as it was prior to the MLFF. Given currently very low population size and other stressors from warmer temperatures, low do and more predators and competitors, there is much greater chance that extreme fluctuating flows such as the non-bypass 2000cfs to 27000cfs will affect the rainbow trout. If you look at figure 8 in the korman 2011 paper, you will notice that te compensatory response is happening when the reproducing population is in the > 2 million eggs part of the stock recuitment curve. however the current population size of rainbow trout is smaller than the 2006 population size which is at the far left of that graph less under a 1 mllion eggs level, so its much less likely there would be a compensatory response. Please include that figure in this LTEMP SEIS and check with GMRC experts like Brian Healy to help interpret why this may mean a compensatory response is a lot less likely. this is a very important consideration because the non-bypass alternative particularly presents this risk to rainbow trout population and to the rainbow trout fishery and this risk needs to be highlighted in this aquatic resources ipacts section and reflected in the table 2-2 summary. The flow spikes and HFEs are likely to have less impact because they don't drop as low	FIGURE 8. Comparison of annual length-at-age relationships for age-0 rainbow trout in the Lees Ferry reach of the Colorado River; the intercept (length at hatch) was set constant among years, but the slope (average growth rate) and variation in length at age were allowed to vary. These relationships were estimated from the data shown in Figure 7. Note that relationships overlap for 2003 and 2004 and for 2008 and 2009 and are difficult to distinguish in the figure. 				 Figure H1. Average catch per unit effort (fish/minute) of rainbow trout at Lees Ferry from Arizona Game and Fish Department's standardized monitoring (electrofishing).				
			3-80	NPS	M Trammell	Typo in middle of first para - ...a fe" brown trou"										
			3-81	NPS	E Omana	Nonnative removals have not occurred in Shinumo Creek since 2014.										
			3-81	NPS	E Omana	This is all very outdated. Removal efforts have continued and are ongoing. Published results are in Healy et al. 2018 and Healy et al. 2020; annual reports summarize data through 2022										
			3-82	NPS	R Billerbeck	The paragraph beginning 'In 2017...' implies that the the proposed project of connecting the slough to to mainstem Colorado was actually done, which it wasn't. Suggest moving the last sentence (as modified below) above the information about the proposed connection project. Otherwise, the information on green sunfish is good for the time period covered, but a lot has happened in the last 3 years that this paragraph doesn't talk about. Green sunfish have increased in extent significantly in the last 3 years - again Melissa Trammell/Emily Omana/Jeff Arnold can provide catch data and Katherine Tucker can provide extent maps. Also there is information from Barrett Freissen (USU) study in the forebay of small green sunfish massing near the dam and good evidence to suggest that smaller green sunfish are entraining through the dam and you state that elsewhere in the plan. Would be good to update this sentence "Despite these efforts, green sunfish are regularly captured by fish monitoring efforts in the mainstem river." with a few sentences about these more recent findings. Melissa Trammell or Jeff Arnold could also provide #'s of GSF that were lethally treated during the last two years rotenone treatments in the slough.										

	2.4		2-4	NPS	S. Haas	Would actions be initiated as soon as temperatures hit these triggers, or after XX hours above this temp, or after XX days? Temps fluctuate throughout the day. Define the trigger more specifically. It matters how long the river is at this temp and SMB may actually breed when the temp is slightly below 16C. Will there be seasonal limits to target just the spawning season, or any time the temp trigger is met? We are assuming it would be based on temperature projections and the operations would be carried out for the full month of when the 15.5C temperature trigger is reached, but it should be clarifiied										
			3-84	NPS	M Trammell	Under Issue 1: It is possible that 'other mitigations' will not be present by 2027, or will not be sufficient to avoid establishment of SMB. To clarify this we suggest changing this sentence to say 'These alternatives were modeled through 2027, with the anticipation that other mitigation factors will be present by 2027; however, if such factors are not present or insufficient to avoid establishment of SMB, implementation of these alternatives may be extended past 2027."										
			3-85	NPS	R Billerbeck	If native fish specific requests here is how to present the SMB lambda modeling results to be comparable to hydropower results for fair evaluation of all the alternatives: 1) The lambda results in appendix A should be inserted here directly given how important these results are to evaluting all the altenratives for purpose and need. The hydropower results are direclty in the text but hydropower is not part of the purpose and need but the efficacy of SMB populatipon reduction is. 2) the figure for the results needs some reformatting - the labels should be below the axis and the solid lines representing where the majority of runs landed should be dot like the other result locations. the level at which most of the results are coming out needs to be labeled (is it 90%, 92%, 95%? Also the figure legend needs to state more clear that lambda below 1 means a decreasing SMB population whereas a lamda over one means an increasing population and a lamba of 2 means the population is doublling. Also you need to state in the figure legend what percent of the runs didn't have any release temperatures over 15.5C - I suspect is 17% or close to that - that is really important to tell because that means that if no action and no bypass are maintaining lambda below 1 for 83% of the runs that is only because the temperatures never got high! so the action part of no bypass is not working to keep lambda below 1 for any runs. If that is true you need to										
			3-86	NPS	M Trammell	the citation (Summit Technologies Inc. 2022) is not included in the list of references. please add.										
			3-86	NPS	R Billerbeck	For no action native fish section, you are missing the biggest issue - that these native fish will be subjected to much higher predation levels from warm water non-native fish as they get established. Increases in smallmouth bass, green sunfish, walleye and others would be very likely to greatly reduce young native fish survival levels. There is abundant evidence from the upper colorado river basin, (Johnson et al. 2008, Bestgen and Hill 2016, Martinez et al. 2014 and other references), that should be stated here to discuss this interaction of smb impacting native fish. This is the most important impact so please add a sentence specific to that here. Also you should mention that spring HFEs are very similar to the natural yearly peak flows that existed pre-dam that the native fish evolved with - that is quite an important fact when discussing the potential impact of spring HFEs. If native fish weren't able to deal with a spring HFE that would be very odd since it would the most like the hydrology that they experienced every year pre-dam.	Martinez, P., K. Wilson, P. Cavalli, H. Crockett, D. Speas, M. Trammell, B. Albrecht, and D. Ryden, 2014, *Upper Colorado River Basin Nonnative and Invasive Aquatic Species Prevention and Control Strategy* . February 2014. https://www.fws.gov/Region6Test/general-information/program-elements/nna/BASINWIDENNFSTRATEGYFeb2014.pdf. Accessed August 27, 2018. and Johnson, B.M., Martinez, P.J., Hawkins, J.A. and Bestgen, K.R., 2008. Ranking predatory threats by nonnative fishes in the Yampa River, Colorado, via bioenergetics modeling. North American Journal of Fisheries Management, 28(6), pp.1941-1953.									

			3-86	NPS	R Billerbeck	For no action non-native fish section, you are missing the biggest issue - that the the non-native fish will increase in numbers and expand downstream in years when river temperature exceeds 15.5C. You need to provide the no action average lambda for the years that exceed 15.5C and you will see its generally over 2 meaning the population of SMB will more than double each year this happens. This is critical to state and to explain - its the biggest and most concening effect of no action and its why we are doing this SEIS and its not clearly stated in this section. Please add a few sentences talking about how Smallmouth bass, green sunfish, walleye and other invasive predators have been increasing, and predation on native fishes is expected to increase as a result, as the invasive predators become established. Increases in smallmouth bass, green sunfish, walleye and others would be very likely to greatly reduce young native fish survival levels (see references in above comment). This is the most important impact so please add a sentence specific to that here.								
			3-88	NPS	R Billerbeck	*predicted λ is > 1 for none of the traces in 2024-2027. For river mile 61, the model predicted λ is > 1 for none of the traces in 2024-2027. No uncertainty in model inputs, functional relationships, or outputs are described* ." While this is correct, you need to interpret that because this is one of the most important results in the plan. Firstly you should stated the inverse, that for all all traces, including all of those where release temp was > 15.5C, it kept the lambda less than 1. You should provide the average lambda for the years or months that exceeded 15.5C and it will show the lambda was < .96. You then need to explain that this result is showing that this would mean the SMB population would be declining - it would get smaller each year. This is versus alternatives like non action and non-bypass that have a lambda well over 1, often over 2 for years or months where temperature > 15.5C. That means those alternatives are allowing the SMB popuation to increase and in fact double when lambda > 2. Please interpret this result clearly for the public. And again, we can't say enought that you need to break out the lambdas for the month or years in the traces that exceeded 15.5C, otherwise you are avearaging it with the 83% of traces where SMB would not be growing anyway. Hydropower broke out their results for those years so SMB impacts need to broken out that way as								
			3-88	NPS	R Billerbeck	For coolmix native fish section, you are missing the biggest issue - that for this alternative there will be much less predation from warm water non-native species than no action - you talk about the effect on non-natives below it, but you need to draw the conclusion in the native fish section that the control of non-antives that this alternative would provide will avoid the much higher predation that would exist under alternatives that do not keep smb lambda under 1 (no action and non-bypass). You need to explain that here.								
			3-88	NPS	R Billerbeck	For coolmix native fish section, you are missing the biggest issue - that for this alternative there will be much less predation from warm water non-native species than no action - you talk about the effect on non-natives below it, but you need to draw the conclusion in the native fish section that the control of non-natives that this alternative would provide will avoid the much higher predation that would exist under alternatives that do not keep smb lambda under 1 (no action and non-bypass). You need to explain that here.								

			3-88	NPS	R Billerbeck	For coolmix non-native fish section, you are missing the biggest issue - that this alternrative will not have growth of warm water invasive fish like SMB, GSF and walleye - those species would DECLINE with an avg lamdba <1 for years or months where relase temp exceeds 15.5C. That is in great contrast to no action and non-bypass that would have incresing populations in those years. Please state that clearly as well as how this altenative reduces predation pressure on native fish.									
			3-89	NPS	R Billerbeck	Where you state "However, since smallmouth bass have been detected mainly in the Glen Canyon reach, implementation of this alternative could still be effective at reducing the likelihood of successful spawning of smallmouth bass where most fish have been found as of the end of 2023." It should also be stated that this is a reason not to delay the use of this tool, because if its not implemented in 2024, then the range of warm water invasives is likely to expand further and this tool would then be less effective.									
			3-90	NPS	R Billerbeck	For cool mix native fish and non-native fish sections, again the obvious most important impact of controlling the SMB and other warm water fish needs to be stated hear and the average lambda for years or months that exceed 15.5C should be stated. The biggest impact on native fish is that their young won't be preyed upon by expanding warm water invasive fish. The biggest impact on non-native fish is that they won't be expanding and in in fact their populations will be decreasing over time. It should also be noted that flow spikes are very much like the naturally timed peak flows that were there every predam in May and June that the native fish evolved with.									
			3-91	NPS	R Billerbeck	Once again where you state "*For river mile 61, the model predicted λ is > 1 for 0 percent of the traces in 2024 but is predicted to be > 1 for 10 percent of the traces evaluated by 2027*." you need to interpret this result for the public and you should state the inverse - under what conditions is it keeping lambda < 1. You also need to talk about not all traces, but what percentage of the traces where release temps > 15.5C. Those are the important years where the tools are needed. And again in the native fish section, you need to state the obvious effect that if warmwater non-natives aren't expanding as much as under no action that this alternative will have more successful native fish reproduction over time. This is so important to state and explain here as it is the reason these alternatives are even being considered. Please add it.									
			3-91	NPS	R Billerbeck	for cold shock with flow spike - where you talk about lambda values, you need the average lambda for the years where release temp > 15.5C provided, you should again state the inverse of the way you do- when does it keep lambda < 1 because that is our goal, and you need to interpret and explain that that means the warm water invasive fish populations would be decreasing rather than increaseing. Again needs to be contrasted with no action and non-bypass where lambdas in those years is well over 1 and often well over 2.									
			3-93	NPS	R Billerbeck	for cold shock with flow spike native fish and non-native fish you need to include the most important effects - that compared to no action or nonbypass young native fish under this alternative would not be subjected to increasing predation from expanding populations of SMB, GSF, that are likely under no action and non bypass. This is the most important effect and needs to be clearly stated and interpreted in these sections									

			3-94	NPS	R Billerbeck	Where you state "The Non-Bypass Alternative consists of weekly flow spikes" you need to clarify more and distinguish from flow spikes in the other alternatives. These aren't just flow spikes - it's a quick drop to 2000cfs followed by a flow spike - this matters because that drop increases that chances of impacting native fish. While an increase from a flow spike in spring is like a natural spring peak flow, this drop followed by an increase is not. This is important. Also you need to state how many of these are occuring under the warmer traces - when is the max# happening in a summer. The flow spikes for the other alternatives are limited to 3. These could occur much more - could be that they would occur every weekend May-Oct - I think that would 26 times - if that is occuring the traces, you need to state that because its VERY VERY different from the flow spikes in teh other alternatives. That is a huge frequency of a flow that would be likely to impact a lot of resources. That is NOT clear in any way from this text to the average reader. Please make it very clear.									
			3-94	NPS	R Billerbeck	*of the traces in 2024 but is predicted to be > 1 for 17 percent of the traces evaluated by 2027. For river mile 61 (confluence with the Little Colorado River), the model predicted λ is > 1 for 3 percent of the traces in 2024 but is predicted to be > 1 for 17 percent of the traces evaluated by 2027."* This needs to be reported as the average lambda for the years where river temp exceed 15.5C. That is important since that only occured in about 17% of the traces. You need to state that is where the 17% is coming from - its the traces where the river gets hot, that this tool doesn't work - just like no action. if you are averaging to include all the traces where this tool wasn't needed you are not showing its effect. If you do it this way, it will show that lambda is over 1 for all the years where we needed to try to control the SMB populations. You need to explain that its not working to prevent increase and expansion of SMB. This is the most critical result of this whole plan and its not intepreted here - you need to explain it. If this alternative is failing to make SMB less than one, then the SMB and other warm water populations will expand and impact native fish at very close to the levels that would occur uner no action. That is not clearly stated in the summary of this plan or in this section and you have to relay that information fairly									
			3-95	NPS	R Billerbeck	Where you state "*For frequency, releases would be weekly to keep bass from successfully renesting.*" you should again state how many of these possible in a summer - from my count it ran from May 1-Oct 31 that would be 26 times - that is huge and important to provide. If its less than that given the occurances in the traces then just provide the average and max in years that have temps over 15.5C.									
			3-95	NPS	R Billerbeck	For the native and nonnative fish sections of the non-bypass, you are missing the most important effects. Based on the lambda modeling, this alternative will experience growth and expansion of SMB, GSF under years where temps are > 15.5C and there will be effects to young native fish from increasing predation from these warmwater invasives. This is not reflected in the text and its the most imprtant conclusion. The effects here to native and non-native should be decribed as very simliar to no-action based on the lambda modeling. This is critical since this alternative may have negative impacts to other resources, yet is not controlling SMB and preventing it from increasing and spreading. This needs to be clearly stated on this page as an impact to native fish and as the effect to the non-native fish population and contrasted with the alternatives that do control SMB.									

			3-95	NPS	R Billerbeck	Where you state "The native Colorado River Basin fish evolved in a highly variable flow environment, and assessments of how juvenile humpback chub use different habitats or their survival rates did not vary during a transition from fluctuating to steady flows below the Little Colorado River (Gerig et al.2014)." but again we would point out that these aren't just flow spikes or hfes that might resemble a natural spring peak... these are fluctations that start with a quick drop to 2000cfs followed by a big flow spike and these would occur at a very high freuqency of every weekend and could occur all the way from May-Oct - which might be a max of 26 times - if that is occuring in any of the traces, you need to state that because its VERY VERY different from the flow spikes in the other alternatives and very different from a natural spring peak. We don't feel like these references or this analysis is complete. We would ask for more input from GCMRC on the effects on native fish in marble canyon from these flows. Particularly the 30 mile aggregation of humpback chub of concern for us with these 26 big fluctations throughout the summer. The waves from these fluctuations do not really substantially ameliorate by the time they reach the LCR, or even Pumpkin springs according to the figure included.									
			3-95	NPS	R Billerbeck	In the non-native fish section of non-bypass, it talks about the mechanism for how this *MIGHT* work but doesn't include and discuss the modeling results for SMB lambda, that suggest it doesn't work to reduce lambda below 1. The lambda values need to included and talked about here. Also when discussing the mechanism for how the flucutations might impact, it states "For smallmouth bass, rising water would flush solar-warmed shoreline nest areas with water at the temperature of main river, potentially causing nest desertion and halting embryo development if the main river temperatures are significantly lower." it says that the temperature difference is what might make this work, but we would stress that this tool will only be used when river temps are over 15.5C and warmer. So the main river temperatures would NOT be significantly lower unless bypass was used. Again, this is really important to provide some clear interp here or more info on how much of a temperature difference is needed. It seems to us this statement indicates why flow spikes paired with bypass cooling might have this effect more than this tool that is used instead of bypass. Please try to evaluate these effects for the flow spike alterantives and explain the mechanism there like you do here.									
			3-95	NPS	R Billerbeck	We are very concerned that it doesn't appear these very frequenct fluctuations with a drop to 2000 then a spike that may be used up to 26 times a summer don't appear like they dissipate by river mile 30 where an aggregation of HBC has persisted for many years. We will like impact to the humpback there and in the upper parts of Marble canyon that would be effected by these fluctuations to be fully addressed.									
			3-96	NPS	R Billerbeck	The effects to rainbow trout discussed here at the top of this page appear to us to be correct, but they don't match your conclusions on the previous section specific to trout or in the summary of effects at the top of the plan. These conclusions are right and need to be used to update the other sections. This section shoudl also note that this non-bypass alternative would be likely to expertince more low DO events and more warm river temperatures that will continue to stress what is already a low population level of rainbow trout that is in poor health condition whereas the bypass alternatives would reduce the temperature and low DO stressors for the rainbow trout.									

			3-96	NPS	R Billerbeck	1) we are concerned that this section uses a reference (Blinn et al 1999) that study that evaluated an early spring high flow and that information is is likely not applicatable to these flows that are drop much lower and run throughout the whole summer. The argument that the dessication is occuring at night is problematic given that the dessication would occur during the hottest parts of the summer when temperatures are much higher at night than during the 1996 spring flow that Blinn considered in this paper. 2) Also with the propagation of the fluctations downstream it won't be at night by the time the fluctuation propagates to the LCR and from figure 2-6 it looks like it doesn't dissipate very much by the time it gets there so it will be happening in daylight in july/aug heat down further. 3) Again, we would highlight that these fluctuations go low before they go high and the frequency and timing are very different than a natural spring peak flow - these are occuring every weekend, potentially all summer so possibly as many as 26 times. The bug flow experiments in the last few years lasted only a few weeks but showed definite changes to macroinvertebrastes, so it seems very challenging to believe that we would conclude these have no impacts. 4) this section seems very incomplete/incorrect regarding food base/macroinvert effects and you need input from Ted									
			3-97	NPS	R Billerbeck	You state that "Previous flow experiments below GCD to interrupt rainbow trout spawning caused mortality of rainbow trout eggs and fry, but recruitment did not decline because of compensatory survival of the remaining young rainbow trout (Korman et al. 2011)." but Korman's work was at time of a much larger and healtheir population of rainbow trout. As we commented on p 3-79, given current rainbow trout population size, and given current health and stressors (low DO, high temp, increasing preadtors), this work is likely not applicable to this situation. Please see our comments up on 3-79 and please contact Brian Healy from GCMRC for more perspective on why comprensatory response is unlikely									
			3-97	NPS	R Billerbeck	This statement needs more qualification "*The five alternatives each have the potential to disrupt smallmouth bass spawning by either desiccating or inundating nesting areas, creating unsuitable water temperatures, or both*." As you say just above this the lambda values for the bypass options are below one, but for the non-bypass its not showing that it performs differently from no action - again you have to get lambda values for the summers in which temperature > 15.5C and see what % of those non-bypass and no action are able to keep lambda less than one - I think it will be zero or nearly zero. these statements that indicate non-bypass actually controls smb are inaccurate, so please edit and qualify those wtih the modeling results.									

			3-97	NPS	R Billerbeck	You state "*Generally, the five alternatives are not expected to have a negative population-wide effect on native fish, as these species have adapted to a large range of flows and temperatures in the Colorado River. However, all alternatives assume that establishment of smallmouth bass will have impacts on native fish populations, which is consistent with the recommendations of the Smallmouth Bass Ad Hoc Group report (2023).*" You need to add these two statements together - because if smallmouth bass will have impacts on native fish populations, then that first sentence is not true - the alternatives that don't control SMB (avg lambda in years > 15.5C) such as no action and no bypass will have a big negative impact on native fish compared to the alternatives that use bypass and control SMB. Or if you look at in comparision to no action then the no bypass will have the same negative impacts as no action but the bypass altenraives will have a positive impact on native fish by comparision.								
			3-97	NPS	R Billerbeck	You state, "*These alternatives are not expected to have long-term negative effects on rainbow trout in the Lees Ferry reach*." but see the comments above about how the rainbow trout popuation in a very different situation then it was for Korman's 2011 study and how assuming compensatory response may not be appropriate. Also alternatives that don't control SMB will likely have added predation affecting rainbow trout at the population level - that may be an important impact to add.								
			3-105-106	NPS	B Holton	You include only three amphibian species in the riparian zone. Change to 5 documented amphibian species, which includes native lowland leopard frog (Rana yavapaiensis) in western GRCA and tiger salamander(Ambystoma mavortium) in the Glen Canyon reach. A single isolated population of lowland leopard frog exists in a perennial side canyon in western GRCA. This population is of unique genetic value, and subject to deleterious effects from aquatic invasive species, such as predatory fish and crayfish. Northern leopard frogs (Rana pipiens) are functionally extinct in GRCA in the riparian zone in the post dam era, but exist in small pockets on the northern rims of GRCA. Northern and lowland leopard frogs are both AZ Species of Special Concern, and habitat suitability models have been created for GRCA in anticipation for future reintroduction and population supplementation efforts.								
			3-106	NPS	B Holton	Change Grand Canyon pink rattlesnake to Western rattlesnake (Crotalus oreganus). Crotalus viridis is the prairie rattlesnake not found in the GC river corridor.								
			3-106	NPS	B Holton	Include potential impacts to native amphibian species from warm water predatory fishes. Predator fish can have adverse effects on amphibians at community and population levels (Watson and Mullin, 2007). Small-mouth bass significantly affected the survivorship of native frogs (eg. red-legged frogs) especially when in combination with other predatory aquatic invasive species (Kiesecker and Blaustein, 1998). Predatory fish have likely rsulted in altered amphibian species assemblages and reduce community diversity (Hecnar and Mcloskey, 1997).								
			3-106	NPS	B Holton	Walston, L.J. and Mullin, S.J., 2007. Responses of a pond-breeding amphibian community to the experimental removal of predatory fish. *The American midland naturalist*, *157*(1), pp.63-73.								
			3-106	NPS	B Holton	Hecnar, S.J. and M'Closkey, R.T., 1997. The effects of predatory fish on amphibian species richness and distribution. *Biological conservation*, *79*(2-3), pp.123-131.								

			3-106	NPS	R Billerbeck	*shallow waters of aquatic and riparian habitats"* you should also provide literature references for how much warmwater non-natives like SMB and GSF impact native amphibians. Here is literature to consider drawing from to include this important effect that will differ among the alternatives: Smallmouth bass and green sunfish predation on amphibians Fish are not the only taxa affected by invasive M. dolomieu; mammals, birds, amphibians, reptiles, and invertebrates can be impacted as well. M. dolomieu will consume almost any prey small enough to ingest including crayfish, rats, mice, young waterfowl, frogs, snakes, and salamanders (Sanderson et al. 2009). Frog species can be impacted by predation from M. dolomieu, although the severity could depend on the presence of other invasive species and the life stage of the frog (Kiesecker and Blaustein 1998). Sanderson BL, Barnas KA, Wargo Rub AM (2009) Nonindigenous species of the Pacific Northwest: An overlooked risk to endangered salmon? BioScience 59(3): 245–256, http://dx.doi.org/ 10.1525/bio.2009.59.3.9 Kiesecker JM, Blaustein AR (2008) Effects of introduced bullfrogs and smallmouth bass on microhabitat use, growth,									
			3-107	NPS	B Holton	Under Mammals: Include that GRCA has the highest diversity of bat species in all NPS units										
			3-110	NPS	R Billerbeck	We disagree with the analysis conclusion that "Under the No Action Alternative there would be no change to the current trajectories for wildlife species that use riparian habitats, including invertebrates, amphibians" We would point to the references we provided for page 3-106 for the abundant literature for SMB and GSF impact amphibian populations. Any amphbians in backwater habitats are likely to be impacts if SMB and GSF establish along the river. There should discussion of that impact for any alternative where the average lambda is greater than 1 in months where temperatures exceed 15.5C									
			3-112	NPS	R Billerbeck	For the Non-bypass alterantive, we would request that you add in impacts to amphibians from increasing popuatlions of SMB and GSF. Based on lambda modeling results, this alternative should perform very simliarlly to no action and these popuations should expand and impact these species throughout the system like they will affect native fish. See references above on page 3-106.									
			3-112	NPS	R Billerbeck	Again where you state "Alternatives with higher daily fluctuations (in particular the Non-Bypass Alternative) would have the potential to lower insect production, potentially resulting in relatively greater impacts on the northern leopard frog." you should add a sentence or two about how alternatives that allow warm water non-natives to increase (no action and non-bypass) that there would be increased predation on northern leopard frogs by SMB and GSF... see above references from page 3-106.									
			3-112	NPS	B Holton	include lowland leopard frogs as a special status species and include with the comment above indicating likely increased predation and lowering survivability with the spread of SMB and GSF.									

			3-113	NPS	R Billerbeck	Here you conclude that HFEs could displace amphbicans and other species, however you don't mention that the non-bypass flucutations may do the same thing. But HFEs would occur typically once a year and, with the action changes to the HFE protocol, 80% of those will be in spring when natural peak flows would have occured, but the non-bypass fluctations may occur up to 26 times a year throughout the summer so they are much more likely to have an impact. Also a much larger and important impact is that SMB and GSF may prey upon amphibians and have greatly reduced amphibicans where they occur. So alternatives which allow SMB and GSF to expand (no action and non-bypass) would have negative impacts to these amphibian popuations (see refs above for p 3-106).								
			3-113	NPS	R Billerbeck	Under special status species, potential impacts to northern leopard frogs from alternatives that allow SMB and GSF to expand should be mentioned.										
			3-124-125	NPA	E Omana	Rogers et al. 2023 Razorback Sucker Xyrauchen texanus Research and Monitoring in the Colorado River Inflow Area of Lake Mead and the Lower Grand Canyon, Arizona and Nevada describes a RBS detection at RM 15										
			3-133 & 3-134	NPS	R Billerbeck	MOST IMPORTANT COMMENT- The effects of non-bypass alternative on HBC does not currently address at all its failure to control SMB and other warm water non-natives - that is the most important effect of this alternative as has comparable performance for SMB lambda in the modeling results to no action. Therefore you need to have the same impacts listed here for the expansion of SMB, GSF and other warm water non-natives on HBC and RBS throughout the system. This is a very important edit- maybe the most important one in this whole analysis. Please include the resutls of the SMB lambda analysis in this section and fully discuss the immpacts with the same text that is in the no action section. It should read, "Based on the SMB lambda modeling results, under the Non-Bypass Alternative, the humpback chub and razorback sucker may be subjected to increasing levels of predation and competition from nonnative fish, especially smallmouth bass and possibly green sunfish and other invasive, aquatic species. Although population levels of humpback chub are likely the highest since construction of Glen Canyon Dam, invasions of nonnative species, especially smallmouth bass, could lead to the decline of some population centers of native fish species, such as near the mouth of the Little Colorado River. Smallmouth bass populations could theoretically expand throughout the Colorado River ecosystem below Glen Canyon								

			3-135	NPS	R Billerbeck	of the five action alterantives will have a population level impact on HBC and other native fish - that is the Non-Bypass alternative. Based the modeling it will not stop SMB and other warm water invasives from growing and expanding and directly affecting HBC by preying upon them. So please reconcile these statements to reflect that if the atlernative doesn't control SMB, then it IS likely to have a population level impact on native fish. This is your statement "*Generally, the five alternatives are not expected to have a negative population-wide effect on native fish, as these species have adapted to a large range of flows and temperatures in the Colorado River. However, all alternatives do assume that smallmouth bass populations will have impacts on native fish populations. These alternatives are not expected to have long-term, negative effects on the rainbow trout in the Lees Ferry reach*." We would suggest rewording it as: "Generally, the four bypass alternatives are not expected to have a negative population-wide effect on native fish, as these species have adapted to a large range of flows and temperatures in the Colorado River. However, all alternatives do assume that smallmouth bass populations will have impacts on native fish populations. Based that, and the modeling of lambda values for SMB populations, the Non-Bypass Alternative may be expected to									
			3-148	NPS	S Haas	The potential changes in vegetation and sandbar size could be substantial depending on the frequency of higher flows and the flow stage changes, within and between years - there is a big dfference between effects if spike flows occur once versus monthly in how sandbars and vegetation would respond to the changing water levels. The sand mass could be depleted quickly following spike flows, and the non-bypass proposed flows especially have the potential to erode beaches quickly, which will affect sandbar size and thus vegetation along the beaches. If you use a qualitative assessment, you need to define what metrics are being used (top of page).									
			3-150	NPS	S Haas	Under Cumulative Effects it states that all flow options would remain within the existing flows outlined in the LTEMP FEIS. Page 2-18: *Under the Non-Bypass Alternative, flows could drop as low as 2,000 cfs and rise as high as approximately 27,300 cfs. The minimum flows proposed under this alternative fall below those developed in the LTEMP ROD (5,000 cfs at night and 8,000 cfs during the day). This alternative would exceed the maximum daily range of 8,000 cfs analyzed in the LTEMP ROD. Modeled ramp rates were slightly outside the LTEMP requirements. Actual ramp rates would be within the operating range of the LTEMP ROD*									
			3-156	NPS	R Billerbeck	On this page for background please include information this year's GCMRC ARM in January about how deam release reached critically low dissolved oxygen levels in 2023 with the elevated river temperatures - this is critical information to include here. Bridget Deemer presented on this and you and can and should include that info as background.									

		figure 3-35	3-157	NPS	R Billerbeck	This figure isn't very readable and again it would be most effective to provide the data for how the alterantives perform different for the years in which temperature was over 15.5C. That is the way to tease out what the tools actually do - otherwise the action is lost in the noise of what is 83% performance of no action. We want to know what a tool does when its needed and its used, not what what it does when its not needed and not used. Having an average value of DO for the most biologically critical months for only those months where temp was over 15.5C and tools were triggered would also be useful in addition to the graph because those values can then be quoted in the impact summary at the top of the document - please do that as was done for hydropower so we can compare all resources equally - compare apples to apples. The ame applies to Figure 3-36 and Figure 3-37.								
		Figure 3-37	3-161	NPS	R Billerbeck	It appears this table is avearging results across all 30 runs and in its current form it is very difficult to understand and tease out differences between alternatives. This is not a fair comparison to hydropower results that are broken out for the months in which the tools in the alternatives are actually used (when temp was over 15.5C) in table 3-25. We believe that is only in 17% of the runs and if you are averaging across all the runs then the results we are seeing are mostly averaged with the 83% of the runs that didn't have DO problems. There hydropwer effects are assessed only the the months in which temperature was over 15.5C and the bypass tools or non-bypass tool where used. If you assess DO the same way, you will show a markedly different set of results that will show DO going a lot lower for some alternatives than others. The alternatives with bypass will perform decidedly better in the years in which those tools are actually needed and actually used. This graph doesn't work as currnetly presented to help distinguish fairly between altearntives.								
		Figure 3-38	3-162	NPS	R Billerbeck	Again - same comment - we don't expect diffeernces between alternaties when the different tools that are triggered - when temp > 15.5C. When temp is < 15.5C then the alterantives don't differ - they all behave like no action. So you need to tease that out to for a fair comparison to hydropower results that are broken out for the months in which the tools in the alternatives are actually used in table 3-25. We believe that is only in 17% of the runs and if you are averaging across all the runs then the results we are seeing are mostly averaged with the 83% of the runs that didn't have DO problems. There hydropwer effects are assessed only the the months in which temperature was over 15.5C and the bypass tools or non-bypass tool where used. If you assess DO the same way, you will show a markedly different set of results that will show DO going a lot lower for some alternatives than others. The alternatives with bypass will perform decidedly better in the years in which those tools are actually needed and actually used. This graph doesn't work as currnetly presented to help distinguish fairly between altearntives.								

			3-163	NPs	R Billerbeck	You state "Across all alternatives, 74 percent of the years by trace combinations would be likely to have mean DO concentrations less than 5 mg/L in the late summer and early fall" but this is not the most important result to compare between alternatives. all the alterantive behave the same in months where temp < 15.5C, they only behave differently in months were temp > 15.5C so those are the months you need to break out there and provide the average DO levels for each alternative under those situations - that is how to compare between the how the alternatives peform for this metric.									
			3-170	NPS	R Billerbeck	This background section on cultural resources fails to explain how dam operations affect sediment deposition and how aeolian transport of the sediment is what keeps cultural sites covered so they are protected from both physical erosion and visitor disturance. Please add these paragraphs from pp. 3-147 and 3-148 from the original LTEMP EIS to explain this important dyanmic: There are a number of ways in which dam operations may affect cultural resources, including the periodicity of inundation and exposure, changing vegetation cover, streambank erosion, slumping, and influencing the availability of sediment. Direct and repeated inundation/exposure may affect resources such as the Spencer Steamboat, which is in the active channel (Figure 3.8-1), or Pumpkin Springs, a TCP along the bank that is subject to inundation during high flows (e.g., equalization flows and HFEs). Streambank erosion, slumping, flowrelated deposition, and indirect effects of deposition may affect cultural resources contained within terrace contexts in proximity to inundated areas. Fine sand or sediment can be blown from flow-deposited source areas and deposited on cultural sites (East et al. 2016) (Figure 3.8-2). The									
			3-170	NPS	R Billerbeck	Please also include the updated information from the January 2024 GCMRC ARM from Joel Sankey and Helen Fairley that documents how many cultural sites have moved out of the 'type 1" site condition where aeolian transport is occuring freely. This transition has happened largely due to the period of no HFEs in the last 5 years. This is an important background condition that makes it imperative to have HFEs with the frequency orignally planned under the LTEMP EIS - so please get their latest info and if needed contact them for the interpretation to get a short paragraph about that current state.									

			3-172	NPS	R Billerbeck	conditions continue, the No Action Alternative could also result in the continued trend of fewer and smaller HFE releases" that seems correct and should be restated here. Currently this section indicates that HFEs will happen just fine under no action, but that ignores the fact that HFEs didn't occur between 2018-2023 even though they were triggered. It would much more accurate and fair to say on p 2-10, that in fact under no action with a lower Lake Powell elevation and that we would expect to have fewer HFEs than LTEMP intendend. This is important because the strategy for depositing and retaining sediment on beaches and sandbars in the LTEMP was based on FREQUENT HFEs. The changes to the HFE protocol to expand the window to 1 year will help address this issue an maitain a frequency of HFEs to protect the resources that is closer to what was originally planned in the LTEMP EIS. See page 3-53 and 3-54 in the original LTEMP EIS that explains why HFEs need to be conducted frequently. You can include a statemetn from the LTEMP EIS p 3-181 that explains why you need frequent HFES - it states "... the net effect of high flows in building eddy sandbars results from the magnitude and the frequency of high flows and the deposition they cause. Erosion ensues rapidly after each high flow, and the rate of erosion declines thereafter but persists. The longer the time									
			3-172	NPS	R Billerbeck	For the Non-Bypass Atlernative on this page, you have some impacts, but you miss one of the bigger and important ones of this alternative. When the # of HFEs are split out by the years that the Non-Bypass tool is actually used, we are pretty sure you will see fewer HFEs and shorter HFEs because of the erosion of sand mass balance in those year - please look at those results and then update this section for the Non-bypass to state that fewer HFEs will impact cultural sites by leading to less deposition and less aeolian transport and therefore more exposure of archeological sites. Ths is a very important dyanamic that has been studies by GCMRC for many years and its one of the important Grand Canyon Protection Act responsibilities that must be addressed. Thank you.									
			3-173, 3-174	NPS	R Billerbeck	on this page and on the 3-174 under the summary you state "*Non-Bypass Alternative - Impacts under the Non-Bypass Alternative would be the same as those impacts described for the Cool Mix Alternative, including sand bar development*" but we do not think this is correct. When the # of HFEs are split out by the years that the Non-Bypass tool is actually used, we are pretty sure you will see fewer HFEs and shorter HFEs because of the erosion of sand mass balance in those year - please look at those results and then update this section.									
			3-178,3-179	NPS	R Billerbeck	Where you discuss taking of life, it should be noted that for No action and non-bypass that if they do not prevent SMB and other warmer water non-natives from growing and expanding that other methods, likely more mechanical and chemical treatements, may need to be used by other agencies to try to control these species.									
			3-179,3-180	NPS	R Billerbeck	As stated above, when sand mass balance and HFEs are broken out for the times that Non-Bypass is used, we think we you will see that									

			3-182	NPS	R Billerbeck	In the paragraph where you state "Recent drought conditions and aridification have resulted in warming water temperatures below Glen Canyon Dam, which could impact rainbow trout energetics and survival (Rogers 2015; Korman et al. 2022)." you should do 2 things - 1) copy this statement to the other parts of the plan where you talk about rainbow trout, 2) add information about the low dissolved oxygen conditions in 2023 that are also adding a major new stressor to the rainbow trout population, and recent information from D. Ragowski and Scott Rodger that the health of the rainbow trout this spring is not good. For information on the low DO conditions in in 2023 look at the presentations from Bridget Deemer and Josh Korman presented at the January 2024 GCMRC ARM.								
			3-182	NPS	R Billerbeck	The wording in this paragraph needs to be changed - it current reads as if we are encouraging a brown trout recreational fishery - the incentivized harvest program is a removal program not a recreational fishery program. You state "*The NPS currently utilizes an incentivized harvest program to encourage anglers to catch and keep brown trout in the Lees Ferry reach. The program has increased the popularity of brown trout fishing since 2016; however, the brown trout fishery in this reach is still not highly sought-after. Fishing in the remainder of this analysis refers to the rainbow trout fishery*." please reword to state this "The NPS currently utilizes an incentivized harvest program to encourage anglers to remove brown trout in the Lees Ferry reach. The program has more participation each year; however, the the number of participants is still low, thought the numbers of fish removed by this small number of anglers has increased greatly and is showing reductions to the population. Fishing in the remainder of this analysis refers to the rainbow trout fishery." You can find a citation for these statements at the January 2024 GCMRC ARM presentations.								
			3-182	NPS	R Billerbeck	Where you state "Most anglers elect no tto fish in the Glen Canyon reach during HFE releases." you should also add information from 2016 LTEMP to discuss how the larger fluctuations on the non-bypass alternative that may occur up to 26 times a summer resembler the preMLFF flows that existed before 1995 and then in sert this pargraph from the 2016 LTEMP EIS p 3-174 that states "High water levels, as well as rapid changes in water levels, directly affect the safety of wading fishermen due to the potential for being swept away by the river current. The 1995 Glen Canyon Dam EIS (Reclamation 1995) included a reference to three drownings that were possibly related to river stage or stage change and noted that high flows (30,000 cfs or more) reduced the safety of wading in the river. After the adoption of the MLFF operating protocol in 1996, ramping rates were restricted, which has likely reduced the level of this risk, as has the reduction of normal high flows to 25,000 cfs."								

			3-182	NPS	R Billerbeck	3-182 you need to add a section about the impacts of larger flucutaitons such as those in the non-bypass alternative, paritcularly the impacts of flows lower than 5,000 cfs. NPS had to warn boaters in sept of 2023 when flows were suddenly reduced to 5,000 cfs and NPS recieved many reports of motorized boating incidents, primarly broken props. Also NPS had to suspend some administration rapid response electrofishing efforts becaue it was felt 5,000 cfs created unsafe navigability situations in Lees Ferry for motorized craft trying to operated at night. Please include in this section somewhere text from the 2016 LTEMP about how flucutations and lower flows impact recreation boating. Here is the 2016 text from p. 3-183: "The Bishop study (Bishop et al. 1987) further evaluated whitewater boater's preferences with respect to levels of daily flow fluctuations. The study, which was conducted at a time when very large fluctuations were common, identified fluctuations in excess of 10,000 cfs as being noticeable and perceived as less natural to canyon visitors. High fluctuations, ranging from 3,000 to 25,000 cfs/day, were also noted as contributing to issues related to selection of campsites, time allowed at attractions, mooring and tending of									
			3-186	NPS	R Billerbeck	again include information in the 2016 LTEMP that is very relevant about how larger flucutations like those in non-bypass option impact camping and how sediment is crucial to maintain recreational campsites that should be included or at least referenced. Please include "High fluctuations, ranging from 3,000 to 25,000 cfs/day, were also noted as contributing to issues related to selection of campsites, time allowed at attractions, mooring and tending of boats, transiting major rapids, and trip scheduling." from LTEMP p. 183 and these sentences from pages 3-179, 3-180 and 3-181 of the LTEMP "The number of available campsites and the amount of campsite area at any particular time are affected by river flow (i.e., fewer campsites are available at higher flows, and vice versa). Because of their singular importance in supporting river use, there have been numerous campsite inventories over the years; NPS reported in the CRMP that there are more than 200 regularly used camping beaches in the GCNP planning area. The number and usability of campsites vary from year to year based on several factors, including flow regimes; vegetation changes; erosion from tributary flooding, wind, or recreation use; or closure of sites to									
			3-190	NPS	R Billerbeck	Where you state, "Reducing the overall rainbow trout population could negatively affect the rainbow trout fishery; however, these effects are not likely to be significant overall due to the short-term nature of flow implementation." We disagree. As stated above in many places, this assumption is based on the Korman 2011 study that assumes a compensatory response from rainbow trout, but the population size being so low now and the additional stressors from high temrperature, low DO, additional predation and other recent poor health indicators suggest it cannot be assumed there would be a compensatory response. Also these non-bypass large flucutations could occur up to 26 times a summer.									

			3-191	NPS	R Billerbeck	For impacts to recreation from the non-bypass alterantive in Glen Canyon, please include a statements that this alternative may have flows every weekend from May-Oct so up to 26 times a summer if conditions call for it. This would require concessions to shut down for those days, which is a much great impact than HFEs once a year or flow spikes 2-3 times a year. This should be clearly stated in this section as the impact could be 20x greater in terms of financial impacts to these small businesses.									
			3-192	NPS	S Haas	The non-bypass flow would create flows below 5000cfs that would not allow for motor boats during the current motor season and would be of such high and low extremes to significantly disrupt river users and cause erosion to beaches. It appears that flows lower than 5000cfs persist down past the LCR and as the flows propigate downstream they will change from happening at night into daytime. Analysis of beach erosion from extreme high and low flows was not sufficiently analyzed in the document. Again sediment metrics need to evaluated for the years or months in which the non-bypass alterantive is occuring to tease out the actual impacts to sediment (erosion and loss of sandmass balance leading to less and shorter HFEs) from the large number of these flucutations (potentiall up to 26) that may occur in a summer. Camping opportunities could be drastically affected due to beach erosion and access issues/boat stranding due to the low volume. for beach erosoin - again please look at HFE, sand mass balance and other sediment stats after they are broken out for the years or months this non-bypass tool is used and we are pretty sure it will show that this tool is having a marked impact on beaches.									
	3.12		3-166	NPS	Brennan	3.12.1 Affected Environment, first sentence should read "The history and importance of Glen Canyon, Marble Canyon, and Grand Canyon..."									
	3.12			NPS	Brennan	Alternative that “available sediment would be similar to that under the No Action Alternative.” Previous studies (Leopold and Maddock 1953, Brooks 1958, Howard and Dolan 1981, Burkham 1986, and Topping et al. 2000) have shown that river-deposited sediment supply has been reduced by flow regimes that result in continual sediment scour from the river bed thus limiting opportunities for sediment deposition on archaeological sites via aeolian processes. Flows of 27,300cfs occurring at weekly intervals would continue, and we believe increase, sediment scour through eastern Grand Canyon and particularly in Marble Canyon. *Continuing loss of sediment would likely lead to a reduction in HFEs which Sankey et al. (2023) have identified as an important “contemporary mechanism” (Sankey 2023, presentation for the Glen Canyon Dam Adaptive Management Program) for increasing sand supply within the river corridor. Sankey et al. (2018) state that “Windblown river sand deposited in dunefield archaeological sites increase cumulatively when upwind river sandbars are resupplied by consecutive annual HFEs.” Loss of sand mass through Marble Canyon could limit our ability to supply necessary sand to protect archaeological sites.*There is a likelihood that the weekly 27,300cfs peak flow could erode, and potentially eliminate existing sand bars that serve as									
	3.12			NPS	Brennan	Other information: East, A.E., Collins, B.D., Sankey, J.B., Corbett, S.C., Fairley, H.C., and Caster, J., 2016, ** East, A.E., Sankey, J.B., Fairley, H.C., Caster, J.J., and Kasprak, A., 2017** Kasprak, A., Sankey, J.B. and Butterfield, B.J., 2021. ** Mueller, E.R. and Grams, P.E., 2021. **Sankey, J.B., Caster, J., Kasprak, A. and East, A.E., 2018. **Sankey, J.B., Caster, J., Kasprak, A. and Fairley, H.C., 2022.									

	3.12.1		3-166	NPS	Brennan	Two confirmed Paleoindian points, a fragmentary Clovis point, and a partial Folsom point have been identified at the Grand Canyon.										
	3.12.1		3-166	NPS	Brennan	Grand Canyon has perhaps the most well know Late Archaic material culture within the study area, including the so called Split Twig Figurine Complex and Grand Canyon Polychrome pictographs. The STFC appears limited to eastern Grand Canyon, while the Grand Canyon Polychrome sites are focused in western Grand Canyon.										
	3.12.1		3-166	NPS	Brennan	There is evidence of Early Formative occupation of Grand Canyon NP										
	3.12.1	1	3-166	NPS	Brennan	I don't think I'd use the word 'emerged" to describe the presence pf Ancestral Puebloan people.										
	3.12.1	1&2	3-166	NPS	Brennan	It would be good to acknowledge that Ancestral Puebloan people retained their ties to the Canyon and returned for many reasons (resources, trade, ceremony, etc).										
	3.12.1		3-167	NPS	Brennan	I am wondering why all your cultural references are for GLCA?										
	3.12.1		3-167	NPS	Brennan	The Havasupai, Hualapi, Navajo, and Southern Paiute all were present in and near the Grand Canyon. Tha Havasupai still live within it.										
	3.12.1		3-167	NPS	Brennan	Grand Canyon also has a significant early EuroAmerican History. Why isn't it included?										
	3.12.1		3-167	NPS	Brennan	The Grand Canyon has 16 cultural Landscapes, including the Canyon itself and the Cross Canyon Corridor (major trails between the North and South Rims in the inner canyon)										
	3.12.1		3-167	NPS	Brennan	Grand Canyon has documented over 500 ethnographic resources within the park, including the river and specific locations within it. We will never know all such resources due to their sensitivity from a tribal perspecitive.										