National Park Service
U.S. Department of the Interior
National Park Service Region
Serving DOI Regions 5, 6, 7, 8 & 9
Glen Canyon National Recreation Area
Grand Canyon National Park

FINDING OF NO SIGNIFICANT IMPACT

FOR THE EXPANDED NON-NATIVE AQUATIC SPECIES MANAGEMENT PLAN IN GLEN CANYON NATIONAL RECREATION AREA AND GRAND CANYON NATIONAL PARK BELOW GLEN CANYON DAM

Recommended:

William Shott, Superintendent
Glen Canyon National Recreation Area

9/3/19
Date

Recommended:

Woody Smeck, Acting Superintendent
Grand Canyon National Park

9.20.19
Date

Approved:

Chip Jenkins, Acting Regional Director
National Park Service Region Serving DOI Regions 5, 6, 7, 8 & 9

10/3/19
Date

INTRODUCTION

In compliance with the National Environmental Policy Act (NEPA), the National Park Service (NPS) prepared an Environmental Assessment (EA) of the environmental impacts of implementing an Expanded Non-Native Aquatic Species Management Plan to control non-native aquatic species in the Colorado River and its tributaries in Grand Canyon National Park (GCNP) and Glen Canyon National Recreation Area (GCNRA) below Glen Canyon Dam. The Proposed Action would expand the tools available for managing non-natives and builds on, but does not modify, those actions identified in the 2013 NPS Comprehensive Fish Management Plan (CFMP; NPS 2013a, b) and Glen Canyon Dam Long-Term Experimental and Management Plan Environmental Impact Statement (LTEMP EIS; Department of Interior [DOI] 2016a, b).

The statements and conclusions reached in this finding of no significant impact (FONSI) are based on documentation and analysis provided in the EA, the revisions documented in the attached errata, and the associated decision file. To the extent necessary, relevant sections of the EA are incorporated by reference below.

SELECTED ALTERNATIVE AND RATIONALE FOR THE DECISION

Based on the analysis presented in the Expanded Non-Native Aquatic Species Management Plan EA (September 2018), NPS has selected the Proposed Action for implementation (hereinafter referred to as the "Selected Action"). The Selected Action was developed by the NPS based on collaboration with Cooperating Agencies and the USGS Grand Canyon Research and Monitoring Center (GCMRC), consultations with the Pueblo of Zuni and Hopi Tribes, public scoping input, a thorough review of scientific data and literature, modeling performed by Argonne National Laboratory, the USGS open file report on possible causes of and interventions to control brown trout increases in the Glen Canyon reach (Runge et al. 2018), and Reclamation's evaluation of options at the RM-12 sloughs (Greimann and Sixta 2018). The Selected Action provides additional tools that are expected to provide better control of non-native aquatic species with little risk to other resources. The tiered and adaptive approach of the Selected Action identifies safeguards for adjusting or stopping actions if unacceptable adverse impacts are observed or projected to occur.

The Selected Action includes control actions that are separated into the following five categories:

- Targeted harvest: changing harvest rates to increase removal of non-native aquatic species. This includes action H1 (H is for Harvest)
- Physical controls: habitat modification or exclusion of specific areas less than 5 ac in size that are identified as source areas for harmful non-native aquatic species (actions P1-P5)
- Mechanical controls: physical removal of non-native aquatic species from habitats (actions M1-M4)
- Biological controls: introduction of organisms to control populations of non-native aquatic species (action B1)
- Chemical controls: limited application of chemicals to control populations of non-native aquatic species (actions C1-C6)

The control actions are summarized in Table1 below.

Table 1. Summary of Selected Action control actions

Action No.	Actions, Triggers, Off-Ramps, and Mitigations[1, 2]	Tier	Target Non-Native Aquatic Species	Target Habitats
Glen Canyon National Recreation Area: Specific Actions for Brown Trout in Glen Canyon Reach				
H1[3]	Incentivized harvest methods which may include a combination of Tribal and volunteer guided fishing, tournaments, prize fish, restoration rewards for target fish harvested and removed, or similar tools to specifically remove and reduce numbers of brown trout from the Glen Canyon reach (timing and other methods may be used to restrict activities)	1	Brown trout	All
M1	Mechanical disruption of early life stage habitats at specific spawning sites, including high-pressure water flushing and mechanical gravel displacement	2	Brown trout	Spawning areas only
M2	Mechanical removal: Species selective electrofishing and trapping, with beneficial use, for long-term control (designed to maximize take of brown trout and minimize incidental take of rainbow trout)	3	Brown trout	All
B1	Introduction of YY male brown trout (may be considered if brood stock exists)	Experi-mental (outside of tiers)	Brown trout	All
Glen Canyon National Recreation Area: Specific Actions in RM -12 Sloughs				
P1	Dewatering using high-volume portable pumps for short time periods (less than 2 weeks). Prior to dewatering, NPS would remove fish from target habitats, move native fish to the main channel, and explore non-lethal relocation of netted green sunfish to Lake Powell including obtaining state permits and sampling/laboratory analysis requirements to ensure only fish free of diseases, pathogens, and parasites are relocated. NPS would plan for beneficial use of all other fish.	1	Any harmful non-native aquatic species	RM -12 Upper Slough only
P2	Placement of selective weirs for specific time periods to disrupt spawning or new invasions	1	Any harmful non-native aquatic species	Both RM -12 sloughs
P3	Placement of non-selective barriers to restrict non-native aquatic species access to tributaries, backwaters, and off-channel habitat areas, and to restrict out-migration	1	Any harmful non-native aquatic species	Both RM -12 sloughs
M2	Mechanical removal: Species selective electrofishing and trapping, (with either beneficial use or live transport/relocation of green sunfish if applicable and permitted), for long-term control	1	Any harmful non-native aquatic species	Both RM -12 sloughs
M1	Mechanical disruption of early life stage habitats at specific spawning sites, including high-pressure water flushing and mechanical gravel displacement	2	Any harmful non-native aquatic species	RM -12 Lower Slough only
C1	Overwhelm ecosystem-cycling capabilities of Upper Slough area (ammonia, oxygen, carbon dioxide, pH, etc.)	3	Any harmful non-native aquatic species	RM -12 Upper Slough and possibly Lower Slough
C2	Rapid response application of registered piscicides for new invasive non-native fish that begin to reproduce in either slough	3	Any new harmful non-native aquatic species rated medium to very high risk	Both RM -12 sloughs
P4	Dredging to connect Upper Slough to Lower Slough, facilitate installation of a water control structure, and allow complete draining of Upper Slough to remove all undesirable non-native aquatic species including green sunfish (Reclamation report Option 6.2; Greimann and Sixta 2018)	4	Any harmful non-native aquatic species	RM -12 Upper Slough only

Action No.	Actions, Triggers, Off-Ramps, and Mitigations[1, 2]	Tier	Target Non-Native Aquatic Species	Target Habitats
M3	Acoustic fish deterrent and guidance devices used in backwater and off-channel habitat areas	1	Any harmful non-native aquatic species	Both RM -12 sloughs
C3	Application of registered piscicides for control of high and very high risk species	4	Any harmful non-native aquatic species rated high to very high risk	Lower Slough only due to inability to exclude or remove all fish
Glen Canyon National Recreation Area: Actions for All Other Areas in Glen Canyon Reach and All Other Non-Native Aquatic Species (Does Not Include Targeting Brown Trout or Actions at RM-12 Sloughs)				
H1	Incentivized harvest methods which may include a combination of Tribal and volunteer guided fishing, tournaments, prize fish, restoration rewards for target fish harvested and removed or similar actions to specifically remove fish from the Glen Canyon reach (timing and other methods may be used to restrict activities)	1	Any harmful non-native aquatic species	All
P1	Dewatering off-channel ponds or small backwaters using high-volume portable pumps	1	Any harmful non-native aquatic species	Small backwaters, off-channel ponds, and low velocity areas < 0.5 ac in size
P2	Placement of selective weirs for specific time periods to disrupt spawning or new invasions of tributaries, backwaters, and off-channel areas	1	Any harmful non-native aquatic species	Backwaters, off-channel ponds, and low velocity areas < 5 ac in size; tributaries
P3	Placement of non-selective barriers restricting non-native aquatic species access to tributaries, backwaters, and off-channel habitat areas and out-migration	1	Any harmful non-native aquatic species	Backwaters, off-channel ponds, and low velocity areas < 5 ac in size; tributaries
M1	Mechanical disruption of early life stage habitats at specific spawning sites, including high-pressure water flushing and mechanical gravel displacement	2	Any harmful non-native aquatic species	Identified spawning areas only
M2	Mechanical removal: Species selective electrofishing and trapping, (with either beneficial use or live transport/relocation of green sunfish if applicable and permitted), for long-term control (designed to minimize incidental take of rainbow trout)	2	Any harmful non-native aquatic species	Spawning and congregation areas only
C1	Overwhelm ecosystem-cycling capabilities of small backwaters and off-channel areas (ammonia, oxygen, carbon dioxide, pH, etc.)	3	Any harmful non-native aquatic species	Small backwaters, off-channel ponds, and low velocity areas < 0.5 ac in size
C2	Rapid response application of piscicides for new invasive non-native fish (medium to very high risk) that begin to reproduce in very localized, and primarily backwater or off-channel areas	3	Any new harmful non-native aquatic species rated medium to very high risk	Backwaters, off-channel ponds, and low velocity areas < 5 ac in size
M3	Acoustic fish deterrent and guidance devices used in backwaters and off-channel habitat areas	1	Any harmful non-native aquatic species	Backwaters, off-channel ponds, and low velocity areas < 5 ac in size

Action No.	Actions, Triggers, Off-Ramps, and Mitigations[1, 2]	Tier	Target Non-Native Aquatic Species	Target Habitats
C3	Application of registered piscicides for control in backwaters and off-channel areas for high or very high risk species only	4	Any harmful non-native aquatic species rated high to very high risk	Backwaters, off-channel ponds, and low velocity areas < 5 ac in size
B1	Introduction of YY male green sunfish or YY males of other medium to very high risk species (may be considered if brood stock exists)	Experi-mental (outside of tiers)	Any harmful non-native aquatic species rated medium to very high risk	All
Grand Canyon National Park: Actions Specific to Colorado River Mainstem and Tributaries				
P1	Dewatering off-channel ponds or backwaters using high-volume portable pumps	1	Any harmful non-native aquatic species	Small backwaters, off-channel ponds, and low velocity areas < 0.5 ac in size
P2	Placement of selective weirs to collect or restrict non-native aquatic species passage to tributaries, backwaters, and off-channel areas	1	Any harmful non-native aquatic species	Small backwaters, off-channel ponds, and low velocity areas < 0.5 ac in size; tributaries
P3	Placement of non-selective barriers restricting non-native aquatic species access to tributaries, backwaters, and off-channel habitat areas and out-migration	1	Any harmful non-native aquatic species	Backwaters, off-channel ponds, and low velocity areas < 5 ac in size; tributaries
M2	Mechanical removal: Species selective electrofishing and trapping, with beneficial use where possible, for long-term control (live capture and relocation would not be logistically practical in this location),	1	Any harmful non-native aquatic species	Small localized spawning and congregation areas
M1	Mechanical disruption of early life stage habitats at specific spawning sites, including high-pressure water flushing and mechanical gravel displacement	2	Any harmful non-native aquatic species	Spawning areas only
C4	Application of registered piscicides for fishery renovation of tributary streams with natural barriers (with mechanical removal and beneficial use in advance)	2	Any harmful non-native aquatic species	Tributaries with natural barriers only
C1	Overwhelm ecosystem-cycling capabilities of small backwaters and off-channel areas (ammonia, oxygen, carbon dioxide, pH etc.)	3	Any harmful non-native aquatic species	Small backwaters, off-channel ponds, and low velocity areas < 0.5 ac in size
C2	Rapid response application of piscicides for new invasive non-native aquatic species (medium to very high risk) that begin to reproduce in very localized, and primarily backwater or off-channel areas	3	Any new harmful non-native aquatic species rated medium to very high risk	Backwaters, off-channel ponds, and low velocity areas < 5 ac in size
M3	Acoustic fish deterrent and guidance devices used in backwater and off-channel habitat areas	1	Any harmful non-native aquatic species	Backwaters, off-channel ponds, and low velocity areas < 5 ac in size

Action No.	Actions, Triggers, Off-Ramps, and Mitigations[1, 2]	Tier	Target Non-Native Aquatic Species	Target Habitats
C3	Application of registered piscicides for long-term control in backwaters and off-channel areas for high or very high risk species only	4	Any harmful non-native aquatic species rated high to very high risk	Backwaters, off-channel ponds, and low velocity areas < 5 ac in size
B1	Introduction of YY males of medium to very high risk species (may be considered if brood stock exists)	Experi-mental (outside of tiers)	Any harmful non-native aquatic species rated medium to very high risk	Tributaries only
P5	Produce small scale temperature changes using a propane heater to adversely affect coldwater non-native fish	Experi-mental (outside of tiers)	Any harmful coldwater non-native aquatic species	Tributaries
Glen Canyon National Recreation Area and Grand Canyon National Park: Control Actions for Plants, Algae, and Mollusks				
M4	Mechanical harvesting of non-native aquatic plants and algae	1	Harmful non-native plants or algae	Backwaters, off-channel ponds, and low velocity areas < 5 ac in size; tributaries
C5	Application of herbicides and non-toxic dyes to backwaters, off-channel areas and tributaries	1	Harmful non-native plants or algae with high to very high risk	Backwaters, off-channel ponds, and low velocity areas < 5 ac in size; tributaries
C6	Application of mollusk repellents and non-toxic anti-fouling paints on boats, equipment used in the river, and NPS water intakes	1	Harmful non-native mollusks	To be used only on boat hulls, equipment and water infrastructure.

[1] Control actions would be applied with their respective tiers, triggers, off-ramps, and mitigation actions which are described in full in the EA in section 2.2 and Table 2-1 (see the full EA at http://parkplanning.nps.gov/Expanded_Nonnative) and updated by the revisions in the errata in Attachment B.
[2] Control actions could be applied singly or in combination with actions of the same tier or lower under the Selected Action, as well as in combination with actions allowed under the CFMP or LTEMP.
[3] Control actions are have an alphanumeric code where H=harvest, M=Mechanical, C=Chemical, B=Biocontrol, P=Physical

CHANGES TO THE SELECTED ACTION IN RESPONSE TO COMMENTS

Following the public release of the EA on September 11, 2018, the NPS received a number of substantive public comments. Below is a summary of the substantive comments that led to revisions to the Proposed Action as described in the EA. For a full list of revisions, see the errata in Attachment B.

1. **Mechanical Disruption M1 (unaffiliated public, anglers, Arizona Game and Fish Department (AGFD)**
    a. Comment: More information is needed on the approach and surveys should be conducted to map the location of the spawning beds prior to implementation.
    Response: The approach was intentionally left flexible in the description because this is an experimental action, however the equipment and potential effects are fully described. We added language to indicate that NPS would conduct a smaller pilot project to test aspects of the approach prior to larger scale implementation. We also added text that we plan to coordinate with the AGFD, GCMRC and others in advance in order to use monitoring efforts effectively to learn more about brown trout. NPS will map the locations of spawning beds prior to full scale implementation.

    b. Comment: Action would cause damage to rainbow trout spawning habitat.
    Response: NPS consulted further with GCMRC and NPS stands by the determination of little effect to the rainbow trout population for this tool. We added more text regarding potential effects particularly in the socioeconomics section. To address this concern we also added text about developing and designing the pilot action cooperatively with AGFD and GCMRC to ensure we develop the best methods with the least effects to rainbow trout prior to implementing this action on a larger scale.

2. **Mechanical Removal M2 (unaffiliated public, anglers)**
    a. Comment: Mechanical removal is not very effective.
    b. Response: NPS disagrees based on the best available information. The EA has been updated to include more information about effectiveness from modeling and other field studies.

    c. Comment: Mechanical removal would have adverse effects on the rainbow trout population or catchability.
    d. Response: NPS consulted further with GCMRC and AGFD, and NPS stands by the determination of little effect to the rainbow trout population for this tool. This impact level was discussed in the Runge et al 2018 report, and NPS believes it is accurate for the Glen Canyon reach based on the timing and approach that would be used on brown trout to minimize impact to rainbow trout. The time period of November 1 through February 28, and the focus on brown trout spawning areas should minimize rainbow trout mortality. In addition, electrofishing equipment settings would be set to minimize adverse impacts, and use the same settings as used by AGFD for their monitoring efforts whenever this action is used in the main channels when rainbow trout or endangered fish might be present. In terms of catchability, text was added to explain that mechanical removal would occur when angling is lowest, in the winter months and that although the feeding activity of fish subjected to the electrical field may be temporarily reduced, the impact would be limited in time and space, as only a short portion of the reach can be electrofished each night, so the effect to angler catch would only occur in the immediate area of treatment on the next day.

3. **Chemical Controls C1, C2, C3, C4 (anglers, AGFD, Southern Nevada Water Authority (SNWA)/Colorado River Commission of Nevada (CRC))**
    a. Comment: Use of chemical controls requires coordination with AGFD.
    Response: NPS consulted further with AGFD on this issue, and added text to better describe consultation and planning in coordination with AGFD, and to identify specific state permits that NPS would seek prior to action.

b. Comment: Experimental chemical controls should not be used.
Response: NPS consulted further with AGFD on this issue, and added text to address this concern. We will consult and plan the experimental design for these experimental treatments with AGFD and GCMRC. The added text states that this action will be primarily for research purposes and management of non-natives would be only a secondary goal when using this action.

c. Comment: For action C5, herbicides may need to be applied more than 5 years in a row to be effective.
Response: The EA text was changed to eliminate the 5-year restriction on herbicide controls, but NPS retained it as a restriction for the use of piscicides and experimental chemical testing actions.

4. Live Transport – part of M1 (anglers, AGFD)

a. Comment: Live transport of non-natives poses a risk and may not be consistent with AGFD policy.
Response: We have consulted further with AGFD and tribes on this issue. AGFD has also coordinated with Utah state agencies on this. NPS revised text to limit live transport to only green sunfish, state that NPS would seek all required state and federal permits, submit a Hazard Analysis and Critical Control Points (HACCP) plan, and subject live fish to be transported to testing.

5. Taking of Aquatic Life (Tribes)

a. Comment: Sonic concussion (M3) involves taking of aquatic life and would be a cruel method of control.
Response: Sonic concussion has been eliminated as a proposed control action and replaced with acoustic fish deterrent and guidance systems (new M3), which are non-lethal acoustic deterrents that would be used to prevent non-native fish from becoming established in suitable habitats.

b. Comment: Mechanical removal (M1) and chemical control (C1-C4) involve unacceptable taking of aquatic life and there is information missing from EA such as the Zuni Tribal Council resolution.
Response: NPS has incorporated a number of actions to reduce taking of aquatic life without beneficial use, including tiered approach, removal and beneficial use prior to renovation and chemical treatments, and live transport of removed green sunfish. NPS has also added reference to Zuni Tribal Council resolution regarding the taking of aquatic life.

6. YY-Males B1 (anglers, Colorado River Energy Distributors Association (CREDA), US Fish and Wildlife Service (FWS), AGFD)

a. Comment: Action has not been field tested in many locations and could have adverse impacts on rainbow trout fishery and humpback chub.
Response: This method would not be considered for implementation until brood stock was available (probably 5-8 years), would be reviewed again before implementing experimentally (including communication with the Adaptive Management Working Group (AMWG) and Technical Working Group (TWG) and consultations if needed. NPS added text to indicate that NPS would evaluate conducting a smaller pilot project in a tributary or would evaluate another comparable introduction by another agency before NPS will consider implementing YY male brown trout in the main stem.

b. Comment: Modeling should be revised to include known rates of movement and other parameters should be re-evaluated (including the lower trigger of 500 brown trout in the Glen Canyon reach).
Response: Text was revised to present new results using known movement rates and remove the lower trigger (500 brown trout as a stop for the action).

7. Socioeconomics Analysis [unaffiliated public, anglers, Western Area Power Administration (WAPA), AGFD]

a. Comment: Analysis underestimates socioeconomic impacts of angler perception and catchability.
Response: NPS consulted further with GCMRC and AGFD on this section, but determined it is very difficult to estimate a "perceived" rather than "real" impact, which could be affected by information disseminated by others. Text has been added to indicate that NPS would work with AGFD to develop educational materials on planned actions and anticipated effects as part of an education campaign to minimize angler misinformation.

8. Incentivized Harvest H1 (anglers, AGFD, Sierra Club, SNWA/CRC)

a. Comment: Provide more funding details.
Response: Some funding information has been added (i.e., total amount dedicated to the program annually). NPS is intentionally leaving flexibility for this program, as it is believed it will require adaptation to determine the best ways and levels to price this program. NPS will plan to work with AGFD and angling groups, such as Trout Unlimited, based on their interest in the implementation.

b. Comment: Extend incentivized harvest area to Badger Rapids.
Response: This area is in GCNP and incentivized harvest is not administratively feasible here.

c. Comment: Oppose 3-year delay on Tier 2 and 3 actions while incentivized harvest is being tested.
Response: A three-year delay has been put in place to address concerns regarding taking of aquatic life without beneficial use, and avoid adverse impacts of mechanical and chemical control actions.

9. Sec. Zinke Memo (anglers, AGFD)

a. Comment: Reference should be made to the September 2018 Secretary Zinke memo and recent Secretarial Orders regarding state authority on DOI lands.
Response: Text was added for consideration given to these directives when working with AGFD.

10. Root Causes of Non-Native Aquatic Species Invasion and Expansion (AGFD, Sierra Club, CREDA, WAPA)

a. Comment: Control actions are reactionary instead of dealing with root cause in a proactive way.
Response: We consulted further with GCMRC on root causes and have added text. We added additional description of the findings of Runge et al. (2018) and the possible need for experimentation to determine underlying causation. Also some letters referred to "100%" or "permanent solutions" which NPS believes is not possible, so NPS added text explaining why there is no 100% solution given the continued passage of non-natives through the dam and the need for maintenance of any actions at locations such as the RM -12 slough.

b. Comment: Implement flow control actions to address root causes.
Response: Alteration of flows is considered out-of-scope for this EA. The Bureau of Reclamation is exploring flow experiments and monitoring of the effects of flows under the LTEMP ROD.

c. Comment: Prefer permanent alteration of RM -12 sloughs to prevent warmwater non-native fish use.
Response: No change has been made. The Selected Action to install a headgate and periodically pump out sloughs as needed to remove water and non-native fish is preferred because it would maintain wetland habitat.

11. Accuracy of Brown Trout Estimates (anglers, SNWA/CRC)

a. Comment: Brown trout estimates are not accurate enough to use as triggers.
Response: NPS conducted additional coordination with GCMRC, AGFD, and USFWS on monitoring issues in November and December 2018, and added additional text regarding monitoring and modeling to establish population estimates and believes that field data in combination with modeling will allow for sufficient estimates for action triggers.

12. Cumulative Impacts (Upper Colorado River Commission (UCRC), Irrigation and Electrical Districts Association of Arizona (IEDA))

a. Comment: Cumulative water quality impacts are inaccurate.
Response: Text revised to more accurately state impacts.

b. Comment: Cumulative impacts are too brief/insufficient.
Response: Text revised to ensure cumulative impacts sufficiently addressed.

RATIONALE

The EA analysis determined that the No-Action Alternative presented risks for expansion of non-native species due to the limited tools available. The Proposed Action was selected because it presented very few, and only limited adverse impacts, and it would best meet the project purposes to:

- Prevent, control, minimize, or eradicate potentially harmful non-native aquatic species, and the risk associated with their presence or expansion, in the project area.
- Address the increase in green sunfish (*Lepomis cyanellus*) and brown trout (*Salmo trutta*) and potential expansion or invasion of other non-native aquatic species.
- Address non-native species threats to downstream native aquatic species, including listed species, or the Lees Ferry recreational rainbow trout (*Oncorhynchus mykiss*) fishery.

MITIGATION MEASURES

In consultation with various state and federal agencies (see Public Involvement/Agency Consultation below for additional details), mitigation measures have been included for the Selected Action. See Attachment A for a complete list of the measures to address natural resource issues. For cultural and tribal mitigations, see Attachment E, Section II of the Programmatic Agreement.

AGENCY CONSULTATION

Cooperating Agencies

In accordance with 43 CFR § 46.225(d), NPS contacted 4 federal agencies, 12 state agencies, and 13 Tribes based on their jurisdiction and special expertise in relation to this project to determine their interest in participating as Cooperating Agencies in preparation of the Expanded Non-Native Aquatic Species Management Plan EA. Of these, the following ten agreed to participate as Cooperating Agencies: (1) Arizona Game and Fish Department, (2) Bureau of Reclamation, (3) Colorado River Board of California, (4) Colorado River Commission of Nevada, (5) Pueblo of Zuni, (6) Southern Nevada Water Authority, (7) Upper Colorado River Commission, (8) U.S. Fish and Wildlife Service, (9) Utah Associated Municipal Power Systems, and (10) Western Area Power Administration.

Monthly teleconferences were held with Cooperating Agencies to provide updates on the status of the development of the Expanded Non-Native Management Plan and EA, and to provide opportunities for discussion. In addition, several in-person meetings, teleconferences, and webinars were held with individual or groups of Cooperating Agencies to address topics and get input within their areas of expertise or jurisdiction during the alternative development process.

Reclamation developed a technical report (Greimann and Sixta 2018) that evaluated various options to reduce temperature in the RM -12 sloughs and reduce their suitability to support non-native warmwater aquatic species. Two of the options (Options 4 and 6.2) were included as control actions (P1 and P4) in the Selected Action.

Glen Canyon Dam Adaptive Management Program and Grand Canyon Monitoring and Research Center

The 1992 Grand Canyon Protection Act led to the creation of the Glen Canyon Dam Adaptive Management Program (GCDAMP), the Adaptive Management Working Group (AMWG) Federal Advisory Committee, and the Grand Canyon Research and Monitoring Center (GCMRC), all of which have interest in the resources downstream of the Glen Canyon Dam. Because of this, the NPS regularly communicated with the GCDAMP, the AMWG, and the GCMRC in addition to monthly meetings with Cooperating Agencies and Tribes. Throughout this EA process, the NPS sought input from GCMRC technical staff on species population status, non-native aquatic species threats, potential control methods, and assessment approaches. The NPS EA team helped organize and participated in workshops associated with development of the Runge et al. (2018) report on underlying causes of and potential interventions for recent brown trout increases in the Glen Canyon reach; several NPS EA team members were co-authors on that report. Runge et al. (2018) provided important information and analyses that were used in development of the EA. Regular updates on the status of the Expanded Non-Native Aquatic Species Management Plan and EA were provided to the AMWG and TWG during public meetings. These updates provided a forum for input to be provided by the GCDAMP stakeholders.

American Indian Tribes

In accordance with the requirements of Section 106 of the National Historic Preservation Act, the NPS mailed letters to 13 tribes on September 5, 2017 and conducted follow-up contacts via emails and phone calls in September, October, and November 2017 to determine which tribes were interested in participating as Cooperating Agencies or otherwise being informed or consulted on the EA. One Tribe participated in the process as a Cooperating Agency, Pueblo of Zuni. Under Section 106 NPS provided opportunities for government-to-government consultations with the interested traditionally-associated Tribes throughout the process. Opportunities included participation in monthly Cooperating Agency teleconferences, an in-person meeting for Tribal representatives (April 10, 2018), and meetings with individual Tribes to seek input and discuss concerns associated with the plan and EA (meeting with Zuni on May 24, 2018, and Hopi on June 11, 2018). Five of the traditionally-associated Tribes are also represented on the GCDAMP, and updates and opportunities for discussions regarding this project were provided at AMWG and TWG meetings throughout this process. Additionally, NPS mailed a follow-up letter to 13 Tribes (25 representatives) on September 12, 2018 to provide information on the NHPA section 106 process related to the EA including the Area of Potential Effect, the expected impacts, and to invite additional consultation. NPS then emailed a draft Programmatic Agreement (PA) on November 2, 2018 to the 9 tribes who indicated interest and Arizona SHPO. A phone call was held on December 3, 2018 to review the PA and 5 Tribes (Zuni, Hopi, Hualapai, Kaibab Paiute, and Navajo) and the Arizona SHPO attended. Tribes and Arizona SHPO commented on the agreement, and NPS incorporated changes and mailed out a revised PA on February 7, 2019. GCNRA staff met in person with the following to further review, clarify, and consider any concerns on these dates: March 15, 2019 – Zuni Tribal Council, ZCRAT, and THPO; April 15, 2019 – Hopi Acting THPO; April 16, 2019 – San Juan Southern Paiute President; April 23, 2019 – Southern Paiute Consortium Coordinator; May 16, 2019 – Kaibab Band of Paiute Tribal Council. Additional comments were made on the PA and a final copy was sent to Tribes in July of 2019. The PA was signed by Pueblo of Zuni, the Navajo Nation, the Hualapai Tribe and then signed and finalized by SHPO on September 10, 2019.

Arizona State Historic Preservation Service (SHPO)

In accordance with the requirements of Section 106 of the National Historic Preservation Act, the NPS sent a notification (via U.S. Post) announcing the NPS intent to prepare an EA on November 14, 20I7 and a follow-up letter on September 12, 2018 to provide additional information related to the Area of Potential Effect and the expected impacts and to invite additional consultation. A copy was also sent to the Advisory Council on Historic Preservation (ACHP). NPS emailed a first draft of the PA on November 2, 2018 to the 9 tribes who indicated interest and to the Arizona SHPO. A phone call was held with Arizona SHPO on November 18, 2018. A phone call was then held with the Tribes and Arizona SHPO on December 3, 2018 to review the first draft of the PA and talk through any concerns or questions. ACHP was also invited to that call but did not attend. Tribes and Arizona SHPO commented on the agreement, and NPS incorporated changes and mailed out a revised draft PA on February 7, 2019. GCNRA staff met in person with the following to further review, clarify, and consider any concerns on these dates: March 15, 2019 – Zuni Tribal Council, ZCRAT, and THPO; April 15, 2019 – Hopi Acting THPO; April 16, 2019 – San Juan Southern Paiute President; April 23, 2019 – Southern Paiute Consortium Coordinator; May 16, 2019 – Kaibab Band of Paiute Tribal Council. Numerous phone and email follow-up contacts were then made. On July 12,2019, all of the participating Tribal representatives were sent the Final version of the Programmatic Agreement and asked to sign. With 3 signatures in hand and verbal commitments to sign from the remaining 3 tribes as soon as their review processes were finished the final PA was sent to SHPO on September 9, 2019 for signature. On September 10, 2019, NPS received concurrence from the Arizona SHPO for this undertaking, Case # SHPO-2017-1572(150340). NPS sent a copy of the signed final PA with SHPO concurrence to the ACHP on September 13, 2019.

Arizona Game And Fish Department (AGFD)

In accordance with 16 USC § 460dd–4, 43 CFR 24.4 and with the 2013 "Master Memorandum of Understanding between United States Department of the Interior National Park Service Intermountain Regional Office and State of Arizona Game and Fish Commission," the NPS has conducted consultation and coordination with AGFD during this EA process. In addition to the monthly cooperator meetings and the updates to the AMWG and the TWG, NPS also coordinated with AGFD through a number of calls and meetings including: December 8, 2017 (scoping comments), January 5, 2018 (scoping comments), March 5, 2018 (alternative development), May 30, 2018 (alternative details), July 6, 2018 (alternative details), August 7, 2018 (administrative draft comments), August 22, 2018 (administrative draft comments), September 10, 2018 (YY male modeling), November 1, 2018 (EA revisions), November 29, 2018 (brown trout monitoring), and February 21, 2019 and February 26, 2019 (section 7 concerns).

US Fish And Wildlife Service (USFWS)

In accordance with the Endangered Species Act of 1973 (16 U.S.C. 153 et seq.) as amended in section 7(a)(2), the NPS consulted with the USFWS on this EA. The NPS initiated informal consultation on October 23, 2017 prior to public scoping. NPS communication with USFWS included: January 4, 2018 (meeting on process and timeline), March 19, 2018 (NPS sent BA outline), May 29, 2018 (NPS sent draft sections of BA), October 4, 2018 (meeting to discuss draft conservation measures), October 16, 2018 (meeting to discuss YY males conservation measures), October 25, 2018 (NPS sent initial draft of the BA), November 14, 2018 (meeting to discuss comments on the draft BA), November 26, 2018 (meeting to discuss YY male conservation measures), November 27, 2018 (NPS sent USFWS the final BA). On March 4, 2019, NPS received the final Biological Opinion for this EA.

PUBLIC INVOLVEMENT

In accordance with CEQ regulation 40 CFR 1500.2(d) and 1506.6(a), the NPS makes diligent efforts to provide opportunities for public involvement in NEPA processes. The public scoping period for the Expanded Non-Native Management Plan extended from November 15, 2017 to January 5, 2018. The NPS invited and encouraged public participation using press releases, a public website for the project, e-mail announcements, and a public newsletter. The NPS also hosted a public webinar and three in-person public meetings in November and December of 2017 to present information about the proposed plan and to invite input regarding the Selected Action, environmental issues that should be addressed, alternatives, and sources of data. A project website (https://parkplanning.nps.gov/Expanded_Nonnative) was used to disseminate information about the public scoping meetings and other information during the development of the Expanded Non-Native Management Plan and EA.

During scoping, a total of 427 comment documents were received from individuals, recreational groups, environmental groups, power customers or organizations, federal and state government agencies, and other organizations. Most comments (approximately 80%) expressed opposition to the removal of trout, especially mechanical removal of brown trout in the Glen Canyon reach using electrofishing. Some commenters were opposed to removal of trout in general, regardless of method or location. About 21% of comments expressed opposition to the Selected Action overall (i.e., actions to control or remove non-native fish), while a few (1%) recognized the need for non-native aquatic species control and supported the Selected Action. Additional details about public scoping and of the issues raised during the scoping process are provided in a public scoping report (available here: https://parkplanning.nps.gov/documentsList.cfm?parkID=62&projectID=74515).

The EA was released for public comment on September 11, 2018 for a 30-day public comment period. The NPS invited and encouraged public participation using press releases, a public website for the project, e-mail announcements, and a public newsletter. The NPS also hosted a public webinar and three in-person public meetings in September 2018 to present information about the EA and to invite public comment. During the public comment period, 58 comment documents were received from individuals, recreational groups, environmental groups, power customers or organizations, federal and state government agencies, and other organizations. A summary of major substantive comments received is provided above on pages 6-9 in the Changes to Selected Action in Response to Comments section.

FINDING OF NO SIGNIFICANT IMPACT

CEQ regulations at 40 CFR section 1508.27 identify ten criteria for determining whether the Selected Action will have a significant effect on the human environment. The NPS reviewed each of these criteria given the environmental impacts described in the EA and determined that there will be no significant direct, indirect, or cumulative impact under any of the criteria.

Impact topics that were dismissed because they did not warrant a full analysis included: air quality, visual/scenic resources, paleontological and geological resources, and soils. Soundscapes were dismissed as a standalone topic, but sound impacts to wildlife and visitor use and experience were considered. Flow-based actions were addressed under the LTEMP EIS and the scope of this action did not include any changes to the LTEMP. Because water delivery and hydropower alterations were not considered as control actions in this EA, potential impacts of the Selected Action on hydropower resources (e.g., electricity generation and hydropower value) were not carried forward for detailed analysis.

As described in the EA, the Selected Action has the potential for beneficial and adverse impacts on aquatic and terrestrial resources in and along the Colorado River below the Glen Canyon Dam in Glen Canyon and Grand Canyon that are identified in the EA; however, no potential for significant adverse impacts was identified.

Potential impacts from the Selected Action disclosed in the EA include:

- Water Quality - Most adverse impacts of control actions on water quality would be short-lived and restricted to a limited number of small areas. Interaction and accumulation of adverse impacts from multiple control actions would be limited because (1) most individual actions and their effects would persist for less than a week, (2) most actions would occur in small (< 5 ac) habitats that are isolated from the main channel and each other, and (3) tiered implementation of actions would reduce the potential for them to occur simultaneously at specific locations.
- Aquatic Resources - Most adverse impacts of control actions on aquatic resources would be restricted to a limited number of small areas (< 5 ac) and for short periods (most actions and their adverse effects would only last for a few hours or days). Interaction and accumulation of adverse impacts from multiple control actions would be limited because (1) most individual actions and their effects would persist for less than a week, (2) most actions would occur in small (< 5 ac) habitats that are isolated from the main channel and each other, and (3) tiered implementation of actions would reduce the potential for them to occur simultaneously at specific locations. Overall benefits are expected to result if non-native aquatic species control efforts are successful.
- Terrestrial Resources - Most adverse impacts of control actions on terrestrial resources would be restricted to a limited number of small areas (< 5 ac) and for short periods (most actions and their adverse effects would only last for a few hours or days). Interaction and accumulation of adverse impacts from multiple control actions would be limited because (1) most individual actions and their effects would persist for less than a week, (2) most actions would occur in small (< 5 ac) habitats that are isolated from the main channel and each other, and (3) tiered implementation of actions would reduce the potential for them to occur simultaneously at specific locations. Overall benefits are expected to result if non-native aquatic species control efforts are successful.
- Tribal and Cultural Resources - No impacts are expected on archaeological sites. Some impacts on Traditional Cultural Properties (TCPs) could result from the taking of aquatic life and short-term impacts on water quality in small treated areas. Some impacts would be reduced by the adaptive tiered approach, implementing beneficial use of removed fish or in some cases implementing live transport of green sunfish following permitting and testing.
- Recreation, Visitor Use, and Experience - Most adverse impacts of control actions on recreation, visitor use, and experience would be restricted to a limited number of small areas (< 5 ac) and for short periods (most actions and their adverse effects would only last for a few hours or days). Interaction and accumulation of adverse impacts from multiple control actions would be limited because (1) most individual actions and their effects would persist for less than a week, (2) most actions would occur in small (< 5 ac) habitats that are isolated from the main channel and each other, and (3) tiered implementation of actions would reduce the potential for them to occur simultaneously at specific locations. Control actions, if successful, would prevent degradation of the rainbow trout fishery and provide benefits to recreation.
- Socioeconomics and Environmental Justice - Control actions under the Selected Action could affect socioeconomics related to the rainbow trout fishery. Interaction and accumulation of adverse impacts from multiple control actions would be limited because (1) most individual actions and their adverse effects would persist for less than a week, (2) most actions would occur in small (< 5 ac) habitats that are isolated from the main channel and each other, and (3) tiered implementation of actions would reduce the potential for them to occur simultaneously at specific locations. If successful, these actions would prevent degradation of the fishery and provide overall benefits to recreation economics.

Environmental justice impacts could result from impacts related to the taking of aquatic life and short-term effects on water quality in small treated areas. Some impacts would be reduced by implementing beneficial use of removed fish.

- Human Health and Safety - Workers implementing control actions would be subject to both physical hazards and potential exposure to chemical substances. Both types of risks would be mitigated and managed to reduce risks to the lowest practical level through the implementation of project-specific health and safety plans prepared under an overarching health and safety program. Park visitors and other members of the public would be excluded from work areas where hazards are present; risks to public, therefore, would be negligible.
- Floodplains and Wetlands – The action that could have the most impact on wetlands would be action P4, but given the limited area of impact (<0.25 acres, limited time period of impact and the resilience of the dominant species in this wetland fringe community, and best management practices listed in Appendix C, section C.4, it is expected that there would be very little impact to the natural wetland processes, functions, and values. This action is exempt under the restoration projects exemptions in the Procedural Manual #77-1 for Wetland Protection (NPS 2016). The Selected Action is consistent with EO 11990 and DO77-1 for wetlands. The Selected Action does not include any development within the floodplains that would increase risks of loss of facilities, or would present additional human safety risks from flooding, so the Selected Action is consistent with EO 11988 and DO77-2 for floodplains.
- Migratory Birds – the Biological Assessment included an appendix A with analysis of effects under the Migratory Bird Treaty Act (MBTA). It found that there could be disturbance to MBTA protected birds in the riparian areas, however there are a number of measures to mitigate sound effects and avoid or minimize adverse effects to breeding, roosting, foraging, and movement activities of MBTA species such that this Selected Action would be in compliance with the MBTA.
- Endangered Species Act – To protect endangered species and comply with the ESA section 7, the NPS consulted with the USFWS and determined that the Selected Action may affect, but is not likely to adversely affect, the five listed birds (Mexican Spotted Owl, Southwestern Willow Flycatcher, California Condor, Western Yellow-billed Cuckoo, and Ridgway s Rail) that may be found in the action area. Our consultation with USFWS found that the selected alternative is likely to adversely affect the two listed fish (razorback sucker and humpback chub) due to incidental take, but the selected action includes many conservation measures to minimize impacts and to ensure that there would not be no significant impacts to these endangered species populations or their critical habitat. The NPS also determined that there will be no effect on any other federally listed threatened or endangered species or critical habitat. The USFWS concurred with the park's determination on March 4, 2019. More information on the effects to federally listed species can be found in the Biological Opinion in Attachment D.
- National Historic Preservation Act - To ensure appropriate treatment of historic properties and compliance with NHPA section 106, the NPS, the Pueblo of Zuni, the Hualapai Tribe, the Navajo Nation, and the Arizona State Historic Preservation Office (SHPO) signed a PA (SHPO signature date of September 10, 2019), for the treatment of historic properties. The Pueblo of Zuni and Hualapai Tribe also submitted a letter with their signature page noting that they protested some of the tools within the management plan, but were signing the PA in order to show their concurrence with the NHPA review process outlined in the PA. The project will not result in significant loss or destruction of scientific, cultural, or historical resources. More information on the effects to tribal and cultural resources can be found in the PA in Attachment E.

&

In summary, the direct and indirect impacts of the Selected Action (Proposed Action) are primarily beneficial through the reduction of non-native aquatic species in the project area. There may be adverse impacts including: temporary and limited terrestrial wildlife or bird disturbance from pump/generator noise, temporary and limited water quality impacts and reductions in macroinvertebrates from chemical treatments, some level of non-target species impact to native fish or other aquatic species during mechanical, physical, biological, and chemical control actions that would also be temporary and limited. There may also be adverse effects to the tribal TCPs from taking of aquatic life during various control actions, but the tiered approach and use of beneficial use or live transport may mitigate those concerns to an extent. For these reasons, all of the resulting adverse effects were determined to be less than significant.

The project will not result in the loss of destruction of significant scientific, cultural, or historical resources, nor will there be any significant impacts on public health, public safety, or unique characteristics of the region. No highly uncertain or controversial impact, unique or unknown risks, significant cumulative effects, or element of precedence were identified. Implementation of the NPS Selected Action will not violate any federal, state, or local environmental protection laws.

CONCLUSION

Based upon the descriptions above and the analysis in the EA, the NPS has determined that the Selected Action will not have a significant effect on the human environment in accordance with Section 102(2)(c) of NEPA and therefore does not constitute an action meeting the criteria that normally requires preparation of an environmental impact statement (EIS). Based on the foregoing, it has been determined that an EIS is not required for this project and, thus, will not be prepared.

REFERENCES

DOI, 2016a, *Glen Canyon Dam Long-Term Experimental and Management Plan Environmental Impact Statement*, October. Available at http://ltempeis.anl.gov/documents/final-eis/. Accessed January 2018.

DOI, 2016b, *Record of Decision for the Glen Canyon Dam Long-Term Experimental and Management Plan Final Environmental Impact Statement,* U.S. Department of the Interior, December. Available at http://ltempeis.anl.gov/documents/docs/LTEMP_ROD.pdf. Accessed January 2018.

NPS, 2013a, *Comprehensive Fisheries Management Plan, Environmental Assessment, Grand Canyon National Park and Glen Canyon National Recreation Area, Coconino County, Arizona*, U.S. Department of the Interior, May. Available at https://parkplanning.nps.gov/documentsList.cfm?projectID=35150.

NPS, 2013b, *Finding of No Significant Impact: Comprehensive Fisheries Management Plan*, National Park Service, U.S. Department of the Interior, December. Available at https://parkplanning.nps.gov/documentsList.cfm?projectID=35150.

Greimann, B. and M. Sixta, 2018, *Temperature Reduction Options for Glen Canyon Slough RM -12*, Upper Colorado Regional Office, Technical Report No. SRH-2018-17, U.S. Department of the Interior, Bureau of Reclamation, Technical Service Center, Sedimentation and River Hydraulics Group, Denver, Colorado, 28 pp.

Runge, M.C., C.B. Yackulic, L.S. Bair, T.A. Kennedy, R.A. Valdez, C. Ellsworth, J.L. Kershner, R.S. Rogers, M.A. Trammell, and K.L. Young, 2018, *Brown Trout in the Lees Ferry Reach of the Colorado River—Evaluation of Causal Hypotheses and Potential interventions*, U.S. Geological Survey Open-File Report 2018–1069, 83 p., https://doi.org/10.3133/ofr20181069.

ATTACHMENTS

Attachment A – Mitigation Measures
Attachment B – Errata
Attachment C – Non-Impairment Determination
Attachment D – Biological Opinion
Attachment E – Programmatic Agreement for NHPA106

ATTACHMENT A: MITIGATION MEASURES

The following mitigation measures will be implemented during the project to minimize the degree and/or extent of adverse impacts.

Avoidance, minimization, and mitigation actions would be implemented under the Selected Action to limit impacts on important resources. These actions would be developed and modified adaptively as the Selected Action is implemented. Prior to any action being conducted, the potential for impacting important resources, including special status and ESA-listed species, cultural resources, resources of importance to Tribes, important recreation areas, and wilderness would be considered, and specific aspects of the action adjusted to avoid or minimize impacts. If necessary, surveys would be conducted for important resources prior to initiation of the action.

Under the Selected Action, certain control actions would not be allowed a priori in some locations to avoid impacts on important resources. The Selected Action does not include mechanical removal of rainbow trout in the Glen Canyon reach where NPS and AGFD are managing for a recreational rainbow trout fishery. However, under existing management practices, electrofishing may be used as a monitoring technique to inform decisions to improve the rainbow trout fishery. In addition, rainbow trout could be affected incidentally during actions targeting other species. Actions would be designed to minimize the incidental mortality of rainbow trout while still achieving objectives, and adaptive improvements would be considered to further minimize effects on rainbow trout.

There are some areas where NPS would not conduct electrofishing or chemical treatments under the Selected Action because, based on past consultations, they are known areas of spiritual significance to Tribes (e.g., Ribbon Falls Creek and Deer Creek). Areas where cultural resource sites (e.g., the Spencer Steamboat) are known to occur would be avoided.

Mitigation could be needed in areas of surface disturbance, and involve restoration of locations after the action is complete. For instance, cofferdams, water control structures, weirs, or other physical barriers would be removed once no longer needed, and this would necessitate minor restoration activities such as regrading mechanically or by hand and placement of cobble to stabilize areas of disturbance. Mechanical disruption of early life stage habitats may require regrading of habitats to restore original contours.

Below are the specific conservation measures that would be used to avoid or mitigate impacts to federally listed or special status native species.

CM-1. Pre-Treatment Surveys to Avoid Impacts to Endangered Fish:
As necessary, surveys would be conducted in the immediate area of a control action for endangered fish prior to initiation of the action. If endangered fish are found, and unless otherwise specified, NPS will assess whether to continue with the action and will apply the appropriate conservation measures as outlined below. Measures in CM-5 and CM-6 would be used to minimize impacts from the survey itself.

CM-2 Measures to Avoid Impacts to Kanab Ambersnail:
No chemical treatments or mechanical removal of fish or aquatic vegetation would occur within 100 m (330 ft) of known locations of Kanab ambersnail. Currently Kanab ambersnail is only known from two locations in the action area, Elves Chasm and Vasey's Paradise. All piscicide or herbicide use would be subject to NPS review and approval processes in strict adherence to applicable regulations and guidelines, and would be implemented at appropriate water levels to ensure that chemicals would not come into contact with ambersnails.

CM-3. Measures to Minimize Impacts on California Condor, Mexican Spotted Owl, Eagles, and Riparian Birds:

- Prior to the start of project activities for the year, GCNP's Wildlife Department will be contacted for any new information related to Mexican spotted owls, California condors, and eagles near the project area. Sensitive species maps will be updated annually with any new information to ensure consistency with the above measures and will be referenced when annual work plans are developed.
- Camping will not occur within 0.25mi of PAC boundaries during the breeding season (March 1 – August 31), until surveys can be done to locate nests. Such situations will be coordinated with the GCNP's Wildlife Department.
- Crews will not exceed 12 people in Mexican spotted owl PACs or suspected occupied areas during the breeding season.
- Any crew access necessary within 0.25 mi of an active condor nest site during the breeding season will be limited to established roads and trails. If access off designated roads or trails or camping is necessary during the breeding season, only activities that occur greater than 0.25 mi from any known or suspected nest area may be conducted. Such situations will be coordinated with GCNP's Wildlife Department.
- Planned projects involving mechanized equipment will not occur within 0.5 mi of active condor nesting sites during the breeding season (February 1 – September 30).
- Flights would occur prior to 10 am whenever possible because condors are less active in the morning hours.
- Aircraft associated with this project would stay at least 1 mi (1.6 km) away from active condor nest locations and vicinities except when human safety would be compromised. The active nesting season is February 1 – September 30. These dates may be modified based on the most current information regarding condor nesting activities (roosting, fledging, etc.) and coordination with GCNP's Wildlife Program Manager, Section 7 Coordinator, and the Service.
- Helicopters will stay at least 1,200 ft (366 m) away from condors in the air, or on the ground or cliffs unless safety concerns override this restriction.
- If airborne condors approach aircraft, aircraft will give up airspace to the extent possible, as long as this action does not jeopardize safety.
- To reduce noise impacts on sensitive wildlife and areas with natural or wilderness characteristics when flying to and from the work area, helicopters would maintain a minimum 2,000 ft altitude where possible, per FAA Advisory Circular 91-36D Visual Flight Rules (VFR) Flight near Noise-Sensitive Areas.
- Pilots would minimize aircraft use along the rim and cliffs to the greatest extent possible. Helicopter pilots will be encouraged to use quieter maneuvers (ones that produce less noise), wherever possible, according to the Fly Neighborly training available at: https://go.usa.gov/xQPCW and https://www.rotor.org/operations/flyneighborly.aspx
- In order to minimize noise disturbance within Mexican spotted owl PAC, helicopters will stay at least 1,200 ft (366 m) away from PAC between March 1 and August 31. If non-breeding is inferred or confirmed during approved-protocol surveys in a Protected Activity Center during the breeding season, restrictions on noise disturbances should be relaxed depending on the nature and extent of the proposed disturbance.
- On a case-specific basis, NPS will assess the potential for noise disturbance to nesting owls. Breeding-season restrictions will be considered if noise levels are estimated to exceed 69 dBA (A-weighted noise level; approximately 80 dBA [owl-weighted noise level, Service 2012]) consistently (i.e., >twice/hour) or for an extended period of time (>1 hr) within 165 ft (50 m) of nesting sites (if known) or within entire Protected Activity Center if nesting sites are not known.
- Except for authorized biologists trained in survey techniques, helicopters and fixed-wing aircraft will avoid operating within 1,200 ft of known eagle nests during the breeding season, except where eagles have demonstrated tolerance for such activity. Potentially disruptive activities will be minimized in the eagles' direct flight path between their nest and roost sites and important foraging areas. Aircraft corridors will be located no closer than 1,200 ft vertical or horizontal distance from known communal roost sites, where possible.
- No helicopter landing zones will be used in suitable breeding habitat for southwestern willow flycatcher, Ridgway's (Yuma clapper) rail or western yellow-billed cuckoo during their respective breeding seasons.

CM-4. Additional Measures to Avoid and Mitigate Disturbance to Riparian Birds, California condors, and eagles:

- Where possible, pumps, heaters and generators that do not exceed 60 dBA, at 50 ft, will be selected, per the NPS Audio Disturbances rule (36 CFR 2.12).
- Where possible, boats that do not exceed 75 dBA, at shoreline, will be selected, per the NPS maximum boat noise rule (36 CFR 3.15). Pressure washers will also be selected for action M1 to conform to this noise rule.
- Where possible crews traveling through riparian areas to get to treatment sites will use established trails and campsites.

CM-5. Mechanical Removal/Electrofishing Conservation Measures (M2):

- Electrofishing gear will be set to avoid injury to all fishes, including rainbow trout in Lees Ferry; the least-intensive electrofishing settings that effectively stuns and captures fish will be used in most cases. For example, during tributary electrofishing in Grand Canyon, a pulsed-DC at a frequency of 30-40 Hz (300-350 volts) has proven to be sufficient in minimizing mortality to both non-native trout and native fishes. However, if no native or non-target species are present in backwater or off-channel areas, settings may be altered to maximize the capture of target species.
- In tributaries where humpback chub have been released, electrofishing equipment use will be minimized in large-volume, deep pools where gear is less effective in capturing fish, and where humpback chub tend to congregate.
- In tributaries or small backwaters, during multiple-pass depletion electrofishing, native fish will be retained in holding areas between passes, or released in a manner that will minimize the likelihood of repeated electrofishing (i.e., away from the sampling areas).
- Non-target fish captured using electrofishing will be monitored in buckets, and gear settings would be adjusted if sufficient shock recovery is not observed.
- Crew members will be sufficiently trained in electrofishing techniques.

CM-6. General Fish Handling:

- Trammel net use will be minimized when possible, and will not be used if water temperatures exceed 20°C, in areas with known presence of ESA-listed fishes. Trammel nets would be checked every 2 hours or less.
- "General Guidelines for Handling Fish" published by the USGS-GCMRC to minimize injury to non-target fish would be followed during all field projects (Persons et al. 2013).
- During sampling efforts, all native fish will be processed first and handling time on captured listed fish will be minimized whenever possible.
- If incidental mortality occurs, humpback chub and razorback sucker otoliths will be extracted and preserved (if feasible) in 100% ethanol, otherwise the entire fish will be preserved as described in Persons et al. (2013) and deposited into GCNP's museum.
- In areas with known presence of ESA-listed fishes, and subject to NPS regulations, no bait, or an artificial or natural substance that attracts fish by scent and/or flavor (i.e., live or dead minnows/small fish, fish eggs, roe, worms, or human food), would be used by anglers participating in non-native fish control efforts. If angling is used in any mechanical removal efforts in GCNP, then barbless hooks would be used for trout removal activities in areas with known presence of listed fishes.

CM-7. Aquatic Invasive Species (AIS) Prevention Measures

- Standard quarantine/hatchery pathogen and disease testing and treatment procedures will be followed to prevent the transfer of AIS from one water to another during live transport of non-native fish species; currently only proposed for green sunfish removed from the 12-Mile Slough in GCNRA to Lake Powell.
- To prevent inadvertent movement of disease or parasitic organisms among aquatic sites, research and management activities shall conform to the Declining Amphibians Population Task Force Field Work Code of Practice (www.nrri.umn.edu/NPSProtocol/pdfs/Amphibians/Appendix%20B.pdf), with the exception that 10% bleach solution or 1% quaternary ammonia should be used to clean equipment rather than 70% ethanol. Abiding by this code will effectively limit the potential spread of pathogens via fish sampling equipment.

CM-8. Conservation Measures for Southwestern Willow Flycatcher

- Surveys of southwestern willow flycatchers through the project area will be conducted periodically (typically every 2 years) as budget allows or in accordance with the Service's 2016 LTEMP Biological Opinion (Service 2016c).
- To ensure that staff have the most current information on flycatchers prior to the start of any management activities under the Selected Action, the GCNP's wildlife department would be contacted for suitable breeding habitat maps and any new occurrence near the project area.
- Southwestern willow flycatcher location, survey maps, and suitable breeding habitat maps will be updated following any new information to ensure consistency with the above measures and will be referenced when annual work plans are developed.
- Suitable southwestern willow flycatcher breeding habitat, as defined in the Southwestern Willow Flycatcher Recovery Plan (Service 2002a), will be avoided for activities which may cause disturbance including Actions M1 (if using pressure sprayer), P1, P5, C1, C2, C3, C4, and C5 (if using noise generating equipment) during the breeding season (May 1-August 31). If there is a need to move forward with any of these actions in suitable breeding habitat during breeding season, then clearance surveys for southwestern willow flycatcher will be conducted during breeding season in the immediate action area to determine if it is occupied or unoccupied prior to the action. NPS will conduct clearance surveys as close to the start of the action as possible, preferably within 1-2 days. If the area is occupied or NPS is unable to conduct clearance surveys, then either the action will not occur during the breeding season or NPS will communicate with the Service AESO prior to the action to determine an appropriate buffer if there is still a reason to consider going forward in this location during that time.
- No helicopter landing zones for this Selected Action will be used in suitable breeding habitat for southwest willow flycatcher during the breeding season unless a clearance survey in the past year has determined it is unoccupied. If the area is occupied or NPS is unable to conduct clearance surveys, then either the action will not occur during the breeding season or NPS will communicate with AESO prior to the action to determine an appropriate buffer if there is still a reason to consider going forward in this location during that time.
- No camping or sustained activities would occur by fisheries crews for this Selected Action, except at already established campsites, in suitable breeding habitat within the breeding season (May 1 – August 31) and travel through these areas will be minimized during this season.
- Habitat modification of riparian areas in this species' suitable breeding habitat would not occur as part of management activities under the Selected Action.

CM-9. Conservation Measures for Ridgway's (Yuma Clapper) rail (primarily GCNP)

- Surveys of Ridgway's rail through the project area will be conducted periodically (typically every 3 years) as budget allows or in accordance with the LTEMP biological opinion.
- To ensure that staff have the most current information on Ridgway's rail prior to the start of any management activities under the Selected Action, the park's wildlife department would be contacted for suitable breeding habitat maps any new occurrence near the project area.
- Ridgway rail locations, survey maps, and suitable breeding habitat will be updated following any new information to ensure consistency with the above measures and will be referenced when annual work plans are developed.
- Suitable breeding habitat will be avoided for activities which may cause disturbance including Actions M1 (if using pressure sprayer), P1, P5, C1, C2, C3, C4 and C5 (if using noise generating equipment) during the breeding season (March 1-July 1). If there is a need to move forward with any of these actions in suitable breeding habitat during breeding season, then clearance surveys for the rail will be conducted during breeding season in the immediate action area to determine if it is occupied or unoccupied prior to the action. NPS will conduct clearance surveys as close to the start of the action as possible, preferably within 1-2 days. If the area is occupied, then either the action will not occur during the breeding season or NPS will

communicate with the Service prior to the action if there is still a reason to consider moving forward in this location and during that time.

- No helicopter landing zones for this Selected Action will be used in suitable breeding habitat for Ridgway rail during the breeding season (March 1-July 1) unless a clearance survey in the past year has determined it is unoccupied. If the area is occupied or NPS is unable to conduct clearance surveys, then either the action will not occur during the breeding season or NPS will communicate with the Service AESO prior to the action to determine an appropriate buffer if there is still a reason to consider going forward in this location during that time.
- No camping or sustained activities would occur by fisheries crews for this Selected Action, except at already established campsites, in suitable breeding habitat within the breeding season (May 1 – August 31) and travel through these areas will be minimized during this season especially in dense riparian vegetation where cattails and/or bulrush are present.
- Habitat modification of riparian areas in this species' suitable breeding habitat would not occur as part of management activities under the Selected Action.

CM-10. Conservation Measures for Western Yellow-Billed Cuckoo (primarily GCNP)

- As funding allows, GCNP would conduct surveys through the project area for the western yellow-billed cuckoo, typically every 3 years. Such surveys may be combined with surveys for other breeding birds and/or southwestern willow flycatchers.
- To ensure that staff have the most current information on cuckoos prior to the start of any management activities under the Selected Action, GCNP's wildlife department would be contacted for suitable breeding habitat maps and any new occurrence near the project area.
- Western yellow-billed cuckoo locations, survey maps, and suitable breeding habitat maps will be updated following any new information to ensure consistency with the above measures and will be referenced when annual work plans are developed.
- Suitable western yellow-billed cuckoo breeding habitat will be avoided for activities which may cause disturbance including Actions M1 (if using pressure sprayer), P1, P5, C1, C2, C3, C4, and C5 (if using noise generating equipment) during the breeding season (May 15 – September 15. If there is a need to move forward with any of these actions in suitable breeding habitat during breeding season, then clearance surveys for the cuckoo will be conducted during breeding season in the immediate action area to determine if it is occupied or unoccupied prior to the action. NPS will conduct clearance surveys as close to the start of the action as possible, preferably within 1-2 days. If the area is occupied or NPS is unable to conduct clearance surveys, then either the action will not occur during the breeding season or NPS will communicate with the Service AESO prior to the action to determine an appropriate buffer if there is still a reason to consider going forward in this location during that time.
- No helicopter landing zones for this Selected Action will be used in suitable breeding habitat for cuckoos during the breeding season (May 15 – September 15) unless a clearance survey in the past year has determined it is unoccupied. If the area is occupied or NPS is unable to conduct clearance surveys, then either the action will not occur during the breeding season or NPS will communicate with the Service AESO prior to the action to determine an appropriate buffer if there is still a reason to consider going forward in this location during that time.
- No camping or sustained activities would occur by fisheries crews for this Selected Action, except at already established campsites, in suitable breeding habitat within the breeding season (May 15 – September 15) and travel through these areas will be minimized during this season.
- Habitat modification of riparian areas in this species' suitable breeding habitat would not occur as part of management activities under the Selected Action.

CM-11. Conservation Measures When Using Piscicides (Rotenone, Antimycin or Ecosystem Cycling Treatments, Action C1, C2, C3, C4):

- For Actions C1, C2, C3, and C4, if any humpback chub or razorback sucker are found during pre-treatment surveys or if there is reason to believe the treatment area is occupied and critical for spawning and rearing,

NPS would communicate with the Service AESO prior to conducting these actions to determine whether to halt this action in this area or conduct salvage relocation.

- NPS would not implement Actions C1, C2, C3, or C4 in the same location for more than 5 consecutive years. If this action is not effective as a long-term solution when implemented over a 5-year period under the implementation of this Proposed Plan, NPS would pursue additional planning and compliance for any subsequent actions not included within this BA.
- Registered piscicide treatments (C2, C3, or C4):
    - NPS would seek state permits and follow state treatment plan requirements and guidelines. Additionally NPS would follow the NPS approval process and required pesticide use plan. Rotenone or antimycin would be applied in accordance with labels and the appropriate standard operating manuals (Finlayson et al. 2010; Moore et al. 2008). Formulations and application rates would be selected to minimize potential effects for birds and mammals and minimize toxicity to aquatic invertebrates. These would be used with standard neutralizing agents.
- Experimental treatments to overwhelm ecosystem cycling capabilities (C1)
    - Treatments with naturally occurring compounds (i.e., ammonia, carbon dioxide, pH alteration, or oxygen-level alteration treatments) could be used for research purposes and to control non-native invertebrate, amphibian, and fish species in targeted, small backwater or off-channel habitat areas (Ward et al. 2011; Ward 2015; Treanor et al. 2017).
    - These would be limited to small backwater areas (< 5 ac) and would be performed under appropriate state experimental permits through ADEQ or other agencies as required.
- Chemical treatments under actions C1, C2, C3, C4 would include:
    - Standard pre-treatment monitoring and watershed assessment within five days prior of application to ensure the treatment area conditions are accurately characterized and representative. This may include: Secchi depth transparency; water temperature, dissolved oxygen, and pH depth profiles; collection of non-native and native fish for use in bioassays; water flow, water quality and soil samples.
    - Barrier construction (if necessary) that could include an impermeable barrier (turbidity curtain) and/or a temporary barrier net may be installed to minimize movement of piscicide from the treatment area into the river (turbidity curtain), and to contain and facilitate removal of dead fish (turbidity curtain and/or net).
    - Native species salvage and relocation prior to piscicide treatment using boat or backpack electrofishing or netting/trapping.
    - Pre-treatment bioassay of water quality conditions would be conducted (e.g., pH, alkalinity, water temperature, sunlight exposure) as needed for adjustments to treatments.
    - Proper storage, transfer and mixing and spill response procedures will be used.
    - Fish will be actively removed during and after the treatment and any remaining fish found at the site will be removed and disposed within 48 hr of treatment at a landfill, or left in place if few in number, small in size, or sunken to the bottom and inaccessible to avian and terrestrial scavengers.
    - Monitoring would include the use of sentinel fish throughout the treatment area, and immediately downstream of the treatment area.

CM-12. Conservation Measures for Incentivized Harvest (H1)

- NPS would make available educational information to anglers in the Glen Canyon reach in the form of signs or information for the identification of humpback chub and razorback sucker, and other native fish, and provide direction to anglers to return these species to the river.
- NPS would make available educational information to anglers in the Glen Canyon reach to discourage any potential non-native introductions.

CM-13. Conservation Measures for YY Male Introductions (B1)

- NPS will communicate with the Service prior to the first introduction of YY male non-native fish to determine if any new studies or modeling suggests that additional consultation is needed. Modeling for any species of YY male would be based on the spreadsheet model for brown trout YY males (Appendix B) and should include new or revised estimates for annual numbers to be stocked, survival/mortality rates, emigration rates, predation rates, and number of years to stock.
- NPS will work with the Service and the Grand Canyon Monitoring and Research Center (GCMRC) prior to implementation to ensure that introduction of YY males is not expected (based on the modeling and current conditions) to cause the Tier 1 or Tier 2 triggering conditions in the LTEMP BO to be reached due to the YY males introduced (given the current status of humpback chub population, the estimated predator index in the Little Colorado River area, and the estimated number of introduced YY male migrants to reach the Little Colorado River). In addition, if the Tier 1 or Tier 2 trigger have already been reached in a given year or are modeled to be reached in the next year, regardless of the YY introductions, then NPS would not introduce YY males in that year.
- Prior to introducing YY male brown trout in the mainstem, a pilot study will be conducted, either by NPS, or a comparable project completed elsewhere by another agency under their own compliance may be substituted.
    - If NPS conducts the pilot study of brown trout YY male introduction, it will be done first on a limited basis for between 2-5 years in a GCNP tributary. Prior to the introduction, NPS will communicate and seek agreement from the Service on the specifics of the stocking level, locations and conditions. The stocking level maximum for a pilot study in GCNP would be 2,000 adult brown trout (or an equivalent number of juveniles adjusted for expected mortality) per year; however, the actual number could be lower based on communication with the Service about current conditions, and the population of brown trout in the action area at that time (e.g. 2017 population of adult brown trout in Bright Angel Creek >230 mm was 626; B. Healy pers. comm. 2018).
    - During the pilot study in GCNP, all brown trout YY males would be PIT tagged to more closely monitor migration and survival rates using existing studies in the tributary and the mainstem, and existing passive antenna arrays.
- Upon conclusion of a pilot study, NPS will communicate about the results with the Service and if there is agreement that this was an applicable and successful study, then NPS may consider a YY male brown trout introduction in the mainstem. NPS may then stock an annual maximum of 5,000 adult brown trout in the Glen Canyon reach (or an equivalent number of juveniles adjusted for expected mortality).
    - After the pilot study, NPS will PIT tag every introduced YY male for the first five years to monitor migration rates. After the first five years, NPS will PIT tag a proportion of the introduced cohort sufficient to continue monitoring migration rates. In addition, NPS will mark or tag all introduced YY males to assist with identification by agencies and anglers.
- YY male non-native fish stocking would be discontinued in a location or for a species if:
    - NPS determines through monitoring or in communication with the Service that the introduced YY male non-native fish are having a negative effect beyond what is estimated based on this consultation process on the humpback chub or razorback sucker populations; or
    - If the rates of survival and migration of YY male brown trout from the stocking location to the Little Colorado River reach are greater than what was modeled; or
    - If the reproductive success of the introduced YY males is determined to be too low to be effective.

  Under these conditions, the NPS would cease introductions and would use mechanical removal or other available tools to remove the introduced YY male non-native fish to reduce and mitigate the threat.
- NPS would communicate and seek agreement with the Service prior to implementation for any new area where YY male brown trout are being considered for introduction.
- Tagging or marking of species other than brown trout is consistent with the approach discussed above.
- To enhance the effectiveness of this method, NPS would utilize incentivized harvest, mechanical removal or other efforts in conjunction with the YY-introductions to reduce the population of wild brown trout.

CM-14. Conservation Measures for Other Control Actions not Covered Above (M1, M2, M3, M4, P1, P2, P3, P4, P5)

- Monitoring for unintended or unacceptable effects and tracking of non-target native or federally listed species encountered in any treatment areas.
- When applicable, prior to control treatment, boat electrofishing and/or barge or backpack electrofishing or netting/trapping will be used to survey and, as appropriate, salvage native species. Native species would be relocated live to another stretch of the same river/stream outside of the treatment area.
- For Action P5 specifically, temperatures would be heated over a period of approximately 8 hr using a propane heater powered by a generator. This would prevent causing temperature shock to the fish. Additionally, NPS would carefully monitor the main channel of the stream below the mixing point to ensure the temperature change is negligible after mixing. Continued monitoring and temperature adjustment would occur after the target temperature is reached.
- For Actions M1, M3, M4, P1, P3, P5 if any humpback chub or razorback sucker are found during pre-treatment surveys or if there is reason to believe the treatment area is occupied and critical for spawning and rearing, NPS would communicate with the Service prior to conducting these actions to determine whether to halt this action in this area. When practicable, NPS would avoid conducting actions in these areas during spawning season for humpback chub and razorback sucker.

CM-15. Conservation Measures for Mollusk Repellents and Herbicides (C5, C6)

- Aquatic application of herbicides (Action C5) would be applied according to label and would be subject to strict guidelines and controls to protect aquatic species and water quality, including the NPS required pesticide use plan and NPS approval processes in strict adherence with applicable regulations and guidelines. Aquatic applications will only occur in backwater and off-channel aquatic habitats and tributaries.
- Mollusk repellents that contain capsaicin will be used on boats and equipment in the river, or non-toxic anti-fouling paints that do not contain copper and are approved for use in Arizona will be used. All use of repellent and anti-fouling paint would be subject to NPS pesticide use plan and approval processes in strict adherence to applicable regulations and guidelines.

CM-16. Interagency Coordination:

- All sampling activities will be coordinated with AGFD (according to 43 CFR part 24) and the Service Arizona Fish and Wildlife Conservation Office and AESO, as well as the USGS-GCMRC or other agencies performing fish monitoring or research within the project-area.
- Annual reports documenting implementation and monitoring conducted by the NPS will be provided to the Service, AGFD, Reclamation, USGS and other interested parties.
- Bi-monthly, or more frequently as needed, conference calls (or written status updates in lieu of a call) will continue to be held by the NPS Fisheries Program to update interested parties on ongoing or new NPS management activities under the Selected Action.
- In the selection of an herbicide (Action C5), NPS will consider (1) the site location to be treated, (2) the non-native vegetation, and (3) the time of year and water temperatures. Herbicide selection will be communicated with the Service and Arizona for a NPDES prior to the initiation of the action.
- If the NPS planned to introduce YY males of species other than brown trout, or in locations other than Glen Canyon reach, or stocking numbers other than those specified in the Proposed Plan were being contemplated, the NPS would communicate and seek agreement with the Service prior to initiation of the action. Also, if prior to the availability of brood stock for YY male brown trout, new modeling or studies become available for brown trout YY males that suggest potentially different mortality/survivorship or migration values or other significant parameters, then NPS would reassess and communicate or consult with the Service as needed. If new information becomes available regarding non-native movement rates and/or predation rates, the model will be re-evaluated to ensure the anticipated impacts of this action on humpback chub or razorback suckers are not greater than anticipated in the current analyses.

ATTACHMENT B: ERRATA

ERRATA IN RESPONSE TO PUBLIC COMMENTS
FOR THE EXPANDED NON-NATIVE AQUATIC SPECIES MANAGEMENT PLAN IN GLEN CANYON NATIONAL RECREATION AREA AND GRAND CANYON NATIONAL PARK BELOW GLEN CANYON DAM ENVIRONMENTAL ASSESSMENT

National Park Service
Region Serving DOI Regions 5, 6, 7, 8, 9
Glen Canyon National Recreation Area
Grand Canyon National Park

September 2019

The following errata, developed in response to public comments, the Finding of No Significant Impact (FONSI), and the Environmental Assessment (EA) describe the final decision of the National Park Service for the Expanded Non-Native Aquatic Species Management Plan in Glen Canyon National Recreation Area and Grand Canyon National Park below Glen Canyon Dam.

Errata

These errata are to be attached to the EA for the Expanded Non-Native Aquatic Species Management Plan in Glen Canyon National Recreation Area (GCNRA) and Grand Canyon National Park (GCNP) below Glen Canyon Dam dated September 2018, and are intended to correct or clarify statements in the EA other than typographical or minor editorial errors and to address substantive comments on the EA received during the public review period.

Page # Line #	Commenter and section of plan	Original Text	Revised Text
Through-out EA	Hopi verbal comment during consultation – global replacement	Taking of life	Taking of aquatic life
P.IV L.9	Anglers - Figures		3-1 Monthly Usage Statistics for Lees Ferry Fishery 69
P.3 L.1	Hopi comment regarding brown trout migration - 1.2 PURPOSE OF AND NEED FOR ACTION	These two non-native fish species had been observed in small numbers, but have recently been reproducing in larger numbers in this reach. Both species have high predation rates on native fish (Yard et al. 2011; Runge et al. 2018; Marsh and Langhorst 1988; Whiting et al. 2014, Ward 2015), raising concerns that large populations of these species in the Glen Canyon reach could lead to large numbers of individuals migrating downstream where they could negatively impact the endangered humpback chub population.	These two non-native fish species had been observed in small numbers, but have recently been reproducing in larger numbers in this reach. Both species have high predation rates on native fish (Yard et al. 2011; Runge et al. 2018; Marsh and Langhorst 1988; Whiting et al. 2014, Ward 2015), raising concerns that, even though brown trout likely migrated upstream into Glen Canyon from Grand Canyon, if reproduction in Glen Canyon led to a large population of this species in the Glen Canyon reach, that could lead to large numbers of individuals migrating downstream where they could negatively impact the endangered humpback chub population.
P.3 L.36	AGFD and anglers comment regarding Secretarial order and authorities - 2 ALTERNATIVES	Under both alternatives, the NPS and Arizona Game and Fish Department (AGFD) will continue to work cooperatively to manage fish and wildlife resources on NPS lands as articulated in the CFMP and the 2013 "Master Memorandum of Understanding between United States Department of the Interior National Park Service Intermountain Regional Office and State of Arizona Game and Fish Commission." Nothing in this EA would change anything in that relationship or any understanding of the jurisdiction or cooperation related to the fishery.	Under both alternatives, the NPS and Arizona Game and Fish Department (AGFD) will continue to work cooperatively to manage fish and wildlife resources on NPS lands as articulated in the CFMP and the 2013 "Master Memorandum of Understanding between United States Department of the Interior National Park Service Intermountain Regional Office and State of Arizona Game and Fish Commission." The NPS has conducted consultation and coordination, and will continue to conduct coordination and consultation, with AGFD in conformance with regulation 43 CFR 24.4, "Resource management and public activities on Federal lands". In addition, the NPS recognizes the intent of the September 10, 2018 Memorandum from Secretary Zinke entitled "State Fish and Wildlife Management Authority on Department of the Interior Land and Waters" as well as Secretarial Order 3356 and has taken these into consideration and will continue to take these into consideration while working cooperatively with AGFD. Nothing in this EA would change anything in that relationship or any understanding of the jurisdiction or cooperation related to the fishery.
P.4 L.3	Hopi clarified wording on beneficial use - 2.1 NO-ACTION ALTERNATIVE	LTEMP experimental actions would continue and be adaptively modified as specified in the LTEMP ROD (DOI 2016b). LTEMP actions related to non-native aquatic species control include (1) mechanical removal of brown and rainbow trout with beneficial use in the mainstem Colorado River near the confluence with the Little Colorado River; and (2) trout management flows.	LTEMP experimental actions would continue and be adaptively modified as specified in the LTEMP ROD (DOI 2016b). LTEMP actions related to non-native aquatic species control include (1) mechanical removal of brown and rainbow trout in the mainstem Colorado River near the confluence with the Little Colorado River with beneficial use of the removed fish; and (2) trout management flows.

P.4 L.12	Sierra club and anglers comments regarding quagga mussels and AIS prevention –2.1 NO-ACTION ALTERNATIVE	NPS also has in place several measures that address prevention and containment of non-native aquatic species including requirements for concessionaire and staff boat washing, angler boot/wader wash stations at the Lees Ferry launch ramp, and signage and outreach to discourage movement of non-natives.	NPS has considered concerns of quagga mussels increasing downstream of the dam given the large population now in Lake Powell. However, Kennedy (2007) assessed the risk of quagga mussels establishing in the Colorado River ecosystem downstream of Glen Canyon Dam and determined that while Dreissena species may establish high densities close to the dam, the risk of them establishing high densities downstream of the Paria River was very low due to "high suspended sediment, high ratios of suspended inorganic:organic material, and high water velocities, all of which interfere with the ability of Dreissena to effectively filter feed." The risk in tributaries was also low for different reasons as there are few upstream sources for Dreissena veligers and upstream movement is expected to be very slow. Currently there are no effective ways of managing Dreissena species in large water bodies, and with a continued supply of larvae coming from Lake Powell, NPS has not identified any feasible management actions that could be used to eradicate or control this species in the river below the dam. However, NPS has in place several existing measures that are components of the No-Action Alternative to address prevention and containment of non-native aquatic species including requirements for concessionaire and agency boat washing, angler boot/wader wash stations at the Lees Ferry launch ramp, and signage and outreach to discourage movement of non-natives.
P.5 L.35	Hopi comment requesting clarification of trout management - 2.2 PROPOSED ACTION	The NPS and AGFD manage for a quality recreational rainbow trout fishery within the 15-mile Glen Canyon reach of GCNRA between Glen Canyon Dam and the Paria River (NPS 2013a, b; AGFD 2015).	The NPS and AGFD manage for a quality recreational rainbow trout fishery within the 15-mile Glen Canyon reach of GCNRA between Glen Canyon Dam and the Paria River (NPS 2013a, b; AGFD 2015). Rainbow trout are managed differently in GCNP than in GCNRA because GCNP, which is a National Park that is dominated by native species and includes two endangered fish species, has a goal of maintaining a native-dominated fish assemblage. On the other hand, GCNRA is a National Recreation Area with fishing and hunting authorized in the enabling legislation. The recreational fishery was being developed by AGFD below the dam before GCNRA was established by Congress, there are fewer native fish in the cold waters of that reach, and no records of endangered fish have been documented in recent years. Brown trout are considered a higher management priority than rainbow trout because brown trout are much more piscivorous and pose a much greater risk to native fish than do rainbow trout in terms of competition and predation (Ward and Morton-Starner, 2015, Runge et al. 2018).
P.6 L.19	Hopi comment regarding taking of aquatic life and NPS	Action also includes monitoring for unintended and unacceptable adverse effects (see Appendix G), "off-ramps" that would be used to determine when control actions should	Action also includes monitoring for unintended and unacceptable adverse effects (see Appendix G), "off-ramps" that would be used to determine when control actions should stop permanently or temporarily in a specific

	internal clarifications of off-ramps - 2.2.1 Implementation Approach for the Proposed Action	stop permanently or until conditions change. Off-ramps are generally based on either the ineffectiveness or adverse effects of the control action. Mitigation would be applied if adverse impacts occur or are anticipated. Information gathered during monitoring would be used to adapt implementation approaches to improve effectiveness and minimize impacts on other resources such as the recreational rainbow trout fishery in the Glen Canyon reach or to address concerns from Tribes regarding the taking of aquatic life of non-native animals.	area until conditions change. Off-ramps are generally based on either the ineffectiveness or adverse effects of the control action, but actions could also be stopped for budgetary reasons, or if they are logistically infeasible in a given location (for instance some actions may not be possible in a remote backcountry area), and some actions may not be appropriate in a specific area or for a specific species. Mitigation would be applied if needed and as specified in the detailed descriptions of actions, if adverse impacts occur or, in some situations, if they are anticipated to occur. Information gathered during monitoring would be used to adapt implementation approaches to improve effectiveness and minimize impacts on other resources such as the recreational rainbow trout fishery in the Glen Canyon reach or to address concerns from Tribes regarding the taking of aquatic life.
P.7 L.9	AGFD, anglers, Sierra Club, GCMRC comments about 'root causes' of non-native introductions and increases. 2.2.1 Implementation Approach for the Proposed Action		A number of factors may contribute to the introduction or increase of non-native aquatic species in the project area. Runge et al (2018) evaluated potential “root causes” for the recent increase of brown trout in the Glen Canyon Reach, and developed several hypotheses including river temperature changes, decreases in rainbow trout populations, food base changes, fall high-flow experiments, and movement upstream from other Colorado River segments in Grand Canyon or tributaries like Bright Angel Creek. However, they concluded that “Ongoing monitoring and research is likely to help resolve some questions about the nature of the brown trout expansion, but causal inference might require experimental intervention.” In discussions regarding brown trout and other non-natives in the system, researchers also hypothesized other factors that could contribute to the introduction or increase of non-natives. These include the spread of non-natives upstream from Lake Mead or other source areas in Grand Canyon, decreases in Lake Powell water levels and subsequent increases in non-native entrainment through the dam, non-native species becoming established in Lake Powell (i.e. gizzard shad and more recently diploid grass carp), changes to the aquatic food base including increases of quagga mussel as a forage item and related fish assemblage changes in Lake Powell (i.e. green sunfish and bluegill increases), as well as other sources of non-native species in tributaries, including from a number of ponds in the Little Colorado River, that might include illegal stocking or flooding events bringing in fish from other water bodies. Given many possible interacting factors for the introduction or increase of non-native species, NPS designed the Proposed Action to be flexible and adaptive to respond to introductions or increases of non-native aquatic species. Although experimental interventions may be required to identify the

			underlying causes of brown trout increases, incentivized harvest and mechanical removal have been included in the Proposed Action as key actions, because these strategies could be effective regardless of the underlying cause of brown trout increases.
P.7 L.15	Jordan, Hamil, Strogen, and Persons, GCMRC and CREDA regarding monitoring and coordination. 2.2.1 Implementation Approach for the Proposed Action	Monitoring that may be performed more frequently or at additional locations on the river could include localized electrofishing, netting, trapping, and tagging (e.g., PIT tags or sonic tags; Zale et al. 2012, Bonar et al. 2009, Skalski et al. 2009). There could be additional administrative motorized or non-motorized river trips and helicopter flights associated with the logistics of certain management or monitoring actions in GCNRA and GCNP.	Monitoring that may be performed more frequently or at additional locations on the mainstem Colorado River or its tributaries could include localized electrofishing surveys, netting, trapping, and tagging (e.g., PIT tags or sonic tags; Zale et al. 2012, Bonar et al. 2009, Skalski et al. 2009). Monitoring for the Proposed Action will be coordinated with GCMRC, AGFD, and the GCDAMP. NPS has also coordinated with the Lower Colorado River Multi-Species Conservation Program, the San Juan River Basin Recovery Implementation Program, and the Upper Colorado River Endangered Fish Recovery Program during the development of this EA and will continue to coordinate with these entities as needed in the future. There could be additional administrative motorized or non-motorized river trips and helicopter flights associated with the logistics of certain management or monitoring actions in GCNRA and GCNP.
P.7 L.29	Hopi clarification comment - 2.2.2 Control Actions Under the Proposed Action	Physical controls: habitat modification or exclusion of specific areas less than 5 ac in size that are identified as source areas for harmful non-native aquatic species;	Physical controls: habitat modification or exclusion of specific areas less than 5 ac in size that are identified as source areas or habitat areas for harmful non-native aquatic species;
P.8 L.34	Zuni concern regarding sonic action - 2.2.2 Control Actions Under the Proposed Action	Beneficial use would be considered for all actions involving non-chemical lethal removal of fish from habitats (incentivized harvest, dewatering, placement of weirs and barriers, mechanical removal, sonic concussion, and tributary renovation) where nonlethal relocation is not feasible. Mechanical removal with salvage of non-native fish for beneficial use may be conducted prior to other actions (e.g., chemical control, sonic concussion) as a partial mitigation to the concerns of some Tribes regarding the taking of life (Section 3.6 for more detail on Tribal concerns). Beneficial use would be performed by placing collected non-native fish into coolers or freezers, and transporting them to Tribes for human consumption, to Tribal aviaries, or for distribution to others for human consumption.	Beneficial use would be considered for all actions involving non-chemical lethal removal of fish from habitats (incentivized harvest, dewatering, placement of weirs and barriers, mechanical removal, and tributary renovation) where non-lethal relocation is not feasible. Mechanical removal with salvage of non-native fish for beneficial use may be conducted prior to other actions (e.g., chemical control) as a partial mitigation to the concerns of some Tribes regarding the taking of aquatic life (Section 3.6 for more detail on Tribal concerns). Beneficial use would be performed by placing collected non-native fish into coolers or freezers, and transporting them to Tribes for human consumption, to Tribal aviaries, or for distribution to others for human consumption.
P.9-19	NPS internal correction to state a majority rather than all – Table 2-1 change made	Off-Ramp: Control action is ineffective in removing or controlling all non-native fish, adequate funding is not available, or long-term unacceptable adverse effects on	Off-Ramp: Control action is ineffective in removing or controlling a majority of non-native fish, adequate funding is not available, or long-term unacceptable adverse effects on native fish or other important resources are expected or observed

	throughout Table 2-1 in all rows where it occurs	native fish or other important resources are expected or observed	
P.9	Based on USFWS consultation - Table 2-1 Glen Canyon National Recreation Area: Specific Actions for Brown Trout in Glen Canyon Reach – M1	Trigger: Number of brown trout adults (>350 mm long) in Glen Canyon reach >5,000. If brown trout adults decrease to below 2,500, then mechanical disruption would cease until the population increases to the initiation trigger of 5,000 adults.	Trigger: Estimated number of brown trout adults (>350 mm long) in Glen Canyon reach >5,000 and there is evidence that reproduction in Glen Canyon is contributing to the continued increase. If brown trout adults decrease to below 2,500, then mechanical disruption would cease until the population increases to the initiation trigger of 5,000 adults.
P.9	Based on USFWS consultation - Table 2-1 Glen Canyon National Recreation Area: Specific Actions for Brown Trout in Glen Canyon Reach – M2	Trigger: LTEMP triggers for mechanical removal of trout at the Little Colorado River confluence have been exceeded and mechanical removal is being implemented there or has been proposed for the following year, AND Brown trout are a contributing proportion of the fish predators in the Little Colorado River area (e.g., 6 adult brown trout [>350 mm] caught in the current or previous year in the Juvenile Chub Monitoring [JCM] reach [RM 63.5-65.2]),	Trigger: LTEMP triggers for mechanical removal of trout at the Little Colorado River confluence have been exceeded (see footnote e) and mechanical removal is being implemented there or has been proposed for the following year, AND Brown trout are a contributing proportion (see footnote h) of the fish predators in the Little Colorado River reach (e.g., 6 adult brown trout h [>350 mm] caught in the current or previous year in the Juvenile Chub Monitoring [JCM] reach [RM 63.5-65.2]),
P.10	Based on USFWS consultation - Table 2-1 Glen Canyon National Recreation Area: Specific Actions for Brown Trout in Glen Canyon Reach – M2	AND Brown trout production in the Glen Canyon reach is an important contributor to the number of adults in the Little Colorado River reach (i.e., the number of adult brown trout in the Glen Canyon reach is > 5,000), OR LTEMP triggers for mechanical removal of trout in the Little Colorado River reach have not been met, but monitoring data and modeling indicate the number of adult brown trout is > 20,000 in the Glen Canyon reach, which using conservative modeling parameters indicates that the population of adult brown trout would reach 47 in the JCM reach, the threshold above which mechanical removal at the Little Colorado River confluence would be ineffective in controlling further increases.	AND Brown trout production in the Glen Canyon reach is an important contributor to the number of adults in the Little Colorado River reach (i.e., the number of adult brown trout in the Glen Canyon reach is > 5,000), OR LTEMP triggers for mechanical removal of trout in the Little Colorado River reach have not been met, but monitoring data and modeling indicate the number of adult brown trout is > 20,000 in the Glen Canyon reach, which modeling using moderate-risk parameters indicates that the population of adult brown trout would reach 47 in the JCM reach, the threshold above which mechanical removal at the Little Colorado River confluence would be ineffective in controlling further increases (Yackulic 2018a).
P.11	USFWS and AGFD comments on triggers - Table 2-1 Glen Canyon National Recreation Area: Specific Actions for Brown Trout in	Introduction of YY male brown trout (may be considered if brood stock exists) Trigger: Experimental evidence and modeling indicate the action may be effective and other actions are shown or projected to be ineffective. Would be considered if the number of brown trout adults (>350 mm long) is more than	Introduction of YY male brown trout (may be considered if brood stock exists) Trigger: Experimental evidence and modeling indicate the action may be effective and brown trout adults (>350 mm long) are present in the reach. Annual stocking would be limited initially to a maximum of 5,000 adult YY-male brown trout, or an equivalent number of juveniles (estimated to

	Glen Canyon Reach – B1	500. Annual stocking would be limited initially to a maximum of 5,000 adult YY-male brown trout, or an equivalent number of juveniles (estimated to be 10,000 based on assumed juvenile survival rates). This number represents a conservative level of risk to humpback chub if survival, movement, and predation rates are at high-risk levels. This maximum number could be adjusted adaptively by ± 4,000 adults (or equivalent juveniles) based on additional modeling or data. If wild brown trout adults in the Glen Canyon reach decrease to below measurable levels for 3 years, then YY-male introduction would cease unless the population increases to above 500 adults. Off-Ramp: Control action is ineffective in controlling brown trout, adequate funding is not available, or long-term unacceptable adverse effects on native fish, rainbow trout, or other important resources are expected or observed Mitigation: Cessation of activity	be 10,000 based on assumed juvenile survival rates). This number represents a conservative level of risk to humpback chub if survival, movement, and predation rates are at high-risk levels. If wild brown trout adults in the Glen Canyon reach are not observed during monitoring for 3 years, then YY-male introduction may cease. Off-Ramp: Control action is ineffective in controlling brown trout, adequate funding is not available, or long-term unacceptable adverse effects on native fish, rainbow trout, or other important resources are expected or observed Mitigation: Cessation of activity or, if appropriate, mechanical removal of introduced YY males
P.11	USFWS, WAPA and NPS Internal clarifications - Table 2-1 Glen Canyon National Recreation Area: Specific Actions in RM -12 Sloughs in Glen Canyon Reach – P1	Dewatering using high-volume portable pumps. Prior to dewatering, NPS would remove fish from target habitats, move native fish to the main channel, and explore non-lethal relocation of netted green sunfish to Lake Powell including obtaining state permits and sampling/laboratory analysis requirements to ensure only fish free of diseases, pathogens, and parasites are relocated. NPS would plan for beneficial use of all other fish. Trigger: If non-native fish are found during regular monitoring and after anytime flow is >23,000 ft3/s [cfs]), exclusion screens would be replaced, then pump-out would be initiated within 3 weeks and the Upper Slough would be dewatered for a period between 2 days (pump to refill) to 2 weeks (naturally refills). Monitoring may lead to adaptation of time periods or triggers, especially if young fish or eggs are present.	Dewatering using high-volume portable pumps for short time periods (no more than 2 weeks total). Prior to dewatering, NPS would remove fish from target habitats, move native fish to the main channel, and explore non-lethal relocation of netted green sunfish to Lake Powell including obtaining state permits and sampling/laboratory analysis requirements to ensure only fish free of diseases, pathogens, and parasites are relocated. NPS would plan for beneficial use of all other fish. Trigger: If non-native fish are found during regular monitoring and after any time flow has been >21,000 ft3/s [cfs] or as indicated by monitoring), exclusion screens would be replaced, then pump-out would be initiated within 3 weeks after disconnection to 3 months depending on if green sunfish are reproducing (shorter time if reproducing). The Upper Slough would be dewatered for no more than 2 weeks. If any pools containing fish remain, >95% of the fish would be removed by electrofishing. Monitoring may lead to adaptation of time periods or triggers, especially if undesirable young fish or eggs are present.
P.11	AGFD comments- Table 2-1 Glen Canyon National Recreation Area: Specific Actions in RM -12 Sloughs in	Mechanical removal: Species selective electrofishing and trapping, (with either beneficial use or live transport/relocation if permitted), for long-term control	Mechanical removal: Species selective electrofishing and trapping, (with either beneficial use or live transport/relocation of green sunfish if applicable and permitted), for long-term control

	Glen Canyon Reach – M2		
P.11	Zuni concerns regarding sonic action - Table 2-1 Glen Canyon National Recreation Area: Specific Actions in RM -12 Sloughs in Glen Canyon Reach – row M3, column Tier Actions, Triggers, Off-Ramps, and Mitigations	Sonic concussion devices used in backwater and off-channel habitat areas Trigger: Presence of medium to very high risk species Off-Ramp: Control action is ineffective in removing or controlling all non-native fish, adequate funding is not available, or long-term unacceptable adverse effects on native fish or other important resources are expected or observed Mitigation: Cessation of activity Tier: 4 Target: Any harmful non-native aquatic species rated medium to very high risk	Acoustic fish deterrent and guidance devices used in backwater and off-channel habitat areas Trigger: Presence Off-Ramp: Control action is ineffective in removing or controlling a majority of non-native fish, adequate funding is not available, or long-term unacceptable adverse effects on native fish or other important resources are expected or observed Mitigation: Cessation of activity Tier: 1 Target Non-Native Aquatic Species: Any harmful non-native aquatic species
P.14	AGFD – Table 2-1 Glen Canyon National Recreation Area: Actions for All Other Areas in Glen Canyon Reach and All Other Non-Native Aquatic Species– M2	Mechanical removal: Species selective electrofishing and trapping, (with either beneficial use or live transport/relocation if permitted), for long-term control (designed to minimize incidental take of rainbow trout)	Mechanical removal: Species selective electrofishing and trapping, (with either beneficial use or live transport/relocation of green sunfish if applicable and permitted), for long-term control (designed to minimize incidental take of rainbow trout)
P.15	Zuni sonic concussive concern - Table 2-1 Glen Canyon National Recreation Area: Actions for All Other Areas in Glen Canyon Reach and All Other Non-Native Aquatic Species– row: M3, columns: Actions, Triggers, Off-ramps, and Mitigations, Tier, Target	Sonic concussion devices used in backwaters and off-channel habitat areas Trigger: Presence of medium to very high risk species Off-Ramp: Control action is ineffective in removing or controlling all non-native fish, adequate funding is not available, or long-term unacceptable adverse effects on native fish or other important resources are expected or observed Mitigation: Cessation of activity Tier:4 Target: Any harmful non-native aquatic species rated medium to very high risk	Acoustic fish deterrent and guidance devices used in backwaters and off-channel habitat areas Trigger: Presence Off-Ramp: Control action is ineffective in removing or controlling a majority of non-native fish, adequate funding is not available, or long-term unacceptable adverse effects on native fish or other important resources are expected or observed Mitigation: Cessation of activity Tier: 1 Target Non-Native Aquatic Species: Any harmful non-native aquatic species
P.16	Based on USFWS consultation - Table 2-1 Glen Canyon National Recreation Area: Actions for All Other	Introduction of YY male green sunfish or YY males of other medium to very high risk species (may be considered if brood stock exists) Trigger: Experimental evidence and modeling indicates the action may be effective and if other actions are shown or	Introduction of YY male green sunfish or YY males of other medium to very high risk species (may be considered if brood stock exists) Trigger: Experimental evidence and modeling indicates the action may be effective, and target non-native fish are present in the area

	Areas in Glen Canyon Reach and All Other Non-Native Aquatic Species– B1	projected to be ineffective for medium to very high-risk species Off-Ramp: Control action is ineffective in controlling non-native fish, adequate funding is not available, or long-term unacceptable adverse effects on native fish, rainbow trout, or other important resources are expected or observed Mitigation: Cessation of activity	Off-Ramp: Control action is ineffective in controlling target non-native fish, adequate funding is not available, or long-term unacceptable adverse effects on native fish, rainbow trout, or other important resources are expected or observed Mitigation: Cessation of activity and, if appropriate, mechanical removal of introduced YY males
P.18	Zuni sonic concussive concern – Table 2-1 Grand Canyon National Park: Actions Specific to Colorado River Mainstem and Tributaries – M3, columns: Actions, Triggers, Off-ramps, and Mitigations, Tier, Target	M3 Sonic concussion devices used in backwater and off-channel habitat areas Trigger: Presence of medium to very high risk species Off-Ramp: Control action is ineffective in removing or controlling all non-native fish, adequate funding is not available, or long-term unacceptable adverse effects on native fish or other important resources are expected or observed Mitigation: Cessation of activity Tier: 4 Target: Any harmful non-native aquatic species rated medium to very high risk	M3 Acoustic fish deterrent and guidance devices used in backwater and off-channel habitat areas Trigger: Presence Off-Ramp: Control action is ineffective in removing or controlling a majority of non-native fish, adequate funding is not available, or long-term unacceptable adverse effects on native fish or other important resources are expected or observed Mitigation: Cessation of activity Tier: 1 Target Non-Native Aquatic Species: Any harmful non-native aquatic species
P.18	Based on USFWS consultation – Table 2-1 Grand Canyon National Park: Actions Specific to Colorado River Mainstem and Tributaries – B1	Trigger: Experimental evidence and modeling indicates the action may be effective and if other actions are shown or projected to be ineffective for medium to very high-risk species. Off-Ramp: Control action is ineffective in controlling non-native fish, adequate funding is not available, or long-term unacceptable adverse effects on native fish or other important resources are expected or observed Mitigation: Cessation of activity	Trigger: Experimental evidence and modeling indicates the action may be effective and target non-native fish are present in the area Off-Ramp: Control action is ineffective in controlling target non-native fish, adequate funding is not available, or long-term unacceptable adverse effects on native fish or other important resources are expected or observed Mitigation: Cessation of activity, and, if appropriate, mechanical removal of introduced YY males
P.19	Nevada and NPS Internal clarification of chemical treatment limitations - Glen Canyon National Recreation Area and Grand Canyon National Park: Control Actions for Plants, Algae, and Mollusks – C5	C5e Application of herbicides and non-toxic dyes to backwaters and off-channel areas Trigger: Presence of high to very high risk aquatic plants or algae Off-Ramp: Control action is ineffective in controlling non-native plants or algae, adequate funding is not available, or long-term unacceptable adverse effects on native fish or other important resources are observed Mitigation: Cessation of activity Tier: 1	C5 Application of herbicides and non-toxic dyes to backwaters, off-channel areas and tributaries Trigger: Presence of high to very high risk aquatic plants or algae Off-Ramp: Control action is ineffective in controlling non-native plants or algae, adequate funding is not available, or long-term unacceptable adverse effects on native fish or other important resources are observed Mitigation: Cessation of activity Tier: 1 Target Non-Native Aquatic Species: Harmful non-native plants or algae with high to very high risk

		Harmful non-native plants or algae with high to very high risk Backwaters, off-channel ponds, and low velocity areas < 5 ac in size; tributaries	Target Habitats: Backwaters, off-channel ponds, and low velocity areas < 5 ac in size; tributaries
P.20	Jordan, Hamil, Strogen, and Persons clarification of wording – Table 2-1 footnote c	NPS is proposing an adaptive tiered approach to non-native aquatic species control. The first actions (Tier 1), would use the least intensive management approach. Tier 1 tools focus on non-lethal and beneficial use methods of controlling or reducing harmful non-natives, result in little alteration of habitat, and are generally lower cost. If lower tier actions are determined to be ineffective or population thresholds (triggers) are reached, NPS would implement higher tier actions that may require more intensive management. Higher tier actions may be more effective in controlling non-native aquatic species, but rely more on lethal methods with beneficial use when possible, have potentially greater effects on habitats or non-target organisms, and generally have higher costs. Several actions either within or among tiers may be used in combination to increase their effectiveness.	NPS is proposing an adaptive tiered approach to non-native aquatic species control. The first actions (Tier 1), would use the least intensive management approach. Tier 1 tools focus on less management intensive and generally more non-lethal methods of controlling or reducing harmful non-natives, result in little alteration of habitat, and are generally lower cost. If lower tier actions are determined to be ineffective or population thresholds (triggers) are reached, NPS would implement higher tier actions that may require more intensive management. Higher tier actions may be more effective in controlling non-native aquatic species, but rely more on lethal methods with beneficial use when possible, have potentially greater effects on habitats or non-target organisms, and generally have higher costs. Several actions either within or among tiers may be used in combination to increase their effectiveness.
P.20	AGFD comments - Table 2-1 footnote d	NPS would plan to implement incentivized harvest for three winters prior to activating the triggers for other brown trout actions in this area. If triggered, other brown trout actions in the Glen Canyon reach would become available after October 31, 2021. If budget constraints, rapid and/or major changes in populations of brown trout or humpback chub, or other unexpected changes were identified, NPS would consult with AGFD and traditionally associated Tribes, communicate with the AWMG and TWG, and discuss if implementation of other actions are necessary sooner. As the action agency, NPS retains final decision–making authority.	NPS would plan to implement incentivized harvest for three winters prior to activating the triggers for other brown trout actions in this area. If triggered, other brown trout actions in the Glen Canyon reach would become available after October 31, 2022. If budget constraints, rapid and/or major changes in populations of brown trout or humpback chub, or other unexpected changes were identified, NPS would consult with AGFD and traditionally associated Tribes, communicate with the AWMG and TWG, and discuss if implementation of other actions are necessary sooner.
P.20	Jim Strogen comment regarding LTEMP BO requirements - Table 2-1 new footnote e		Several LTEMP Tier 1 actions specified in the LTEMP EIS (DOI 2016) must prove to be ineffective (i.e., fail to slow or reverse the decline in the humpback chub population) before the LTEMP Tier 2 action of mechanical removal is implemented. LTEMP Tier 1 actions include expanded translocation of humpback chub within the Little Colorado River, and implementation of a head-start program for larval humpback chub.
P.20	SNWA/Nevada clarification of chemical treatment restrictions – Table 2-1 new footnote f	NPS would not implement this action in the same location for more than 5 consecutive years. If this action is not effective as a long-term solution when implemented over a 5-year period, NPS would pursue additional planning and	NPS would not implement actions C1 or C3 in the same location for more than 5 consecutive years. If these actions are not effective as a long-term solution when implemented over a 5-year period under this EA, NPS would pursue additional planning and compliance for any subsequent actions not included within this EA.

		compliance for any subsequent actions not included within this EA.	
P.20	NPS Internal consistency – Table 2-1 renumbered footnote f to g	A "new" non-native aquatic species is one that previously was not observed in the project area or was only present in small numbers.	A "new" non-native aquatic species is one that previously was not observed in the project area or was only present in small numbers.
P.20	USFWS – Table 2-1 new footnote h		The number of 6 adult brown trout was set as a trigger because this small number of captures indicates the presence of a greater number of brown trout in this area. It represents a likely fraction of the total number of brown trout present in the reach, based on a range of measured capture probabilities of brown trout at the Little Colorado River confluence. This number includes the annual cumulative total of any brown trout captured in the Juvenile Chub Monitoring (JCM) reach during any kind of annual monitoring or mechanical removal trip. If mechanical removal is being implemented in full in the Little Colorado River reach, and a total of 36 passes are made, then it is likely at least 6, and likely more than 15 brown trout would be captured, if the moderate or high risk assumptions are correct. If at least 6 brown trout are captured in the JCM reach during the standard annual monitoring occasions, before mechanical removal is triggered at the Little Colorado River, it indicates the brown trout population there has increased to the point where the moderate or high risk assumptions are correct, and an upstream source is likely, which must be addressed.
P.21 L.1	Anglers and AGFD comment requesting more detail on incentivized harvest funding – 2.2.2.1 Targeted Harvest Control	(1) scheduled and funded guided angling trips for Tribal youth, members, or volunteers; (2) providing incentives for guides to increase the number of targeted fish harvested during fishing trips; (3) Restoration Rewards (i.e., monetary award paid to fishermen for catching and consuming targeted non-native fish and providing information on captured fish); and (4) awards for tagged target fish, and other tournament incentives during angling organization-sponsored events. Incentivized harvests might only be scheduled during periods when target fish are most susceptible to harvest to reduce administrative costs. NPS or partners may provide informational brochures that include mapped locations of prime areas to collect target fish, approved fishing techniques, and optimum angling time periods to further enhance the take of undesirable species. The administration and/or funding of these actions could be federal, state, or from a third party. Funding and administration of this	Incentivized Harvest (Action H1; Tier 1). Incentivized harvest would be used only by GCNRA in the Glen Canyon reach. Under this Tier 1 action, incentives would be provided to anglers to remove target non-native fish and encourage human consumption of the fish. Incentivized harvest was identified by anglers during public scoping as a method of controlling brown trout in the Glen Canyon reach. Incentivized harvest could include: (1) scheduled and funded guided angling trips for Tribal youth, members, or volunteers; (2) providing incentives for guides to increase the number of targeted fish harvested during fishing trips; (3) Restoration Rewards (i.e., monetary award paid to fishermen for catching and consuming targeted non-native fish and providing information on captured fish); and (4) awards for tagged target fish, and other tournament incentives during angling organization-sponsored events. Incentivized harvests might only be scheduled during periods when target fish are most susceptible to harvest to reduce administrative costs. NPS or partners may provide informational brochures that include mapped locations of prime areas to collect target fish, approved fishing techniques, and optimum angling time

		program could change over time to increase efficiencies and to include new non-native aquatic species that are considered a medium to very high risk to the rainbow trout or endangered and native species downriver. NPS would plan to implement incentivized harvest for three winters prior to implementing other brown trout actions in the Glen Canyon reach. If triggered, other brown trout actions in the Glen Canyon reach would become available after October 31, 2021. If budget constraints, rapid and/or major changes in populations of brown trout or humpback chub, or other unexpected changes were identified, NPS would consult with AGFD and traditionally associated Tribes, communicate with the AWMG and TWG, and discuss if implementation of other actions are necessary sooner. As the action agency, NPS retains final decision–making authority.	periods to further enhance the take of undesirable species. The administration and/or funding of these actions could be federal, state, or from a third party. NPS is anticipating the need for an annual fund of approximately $50,000-$250,000 for this action, but that may depend greatly on population size, catch rates and response to initial efforts as well as partner participation. Funding and administration of this program could change over time to increase efficiencies and to include new non-native aquatic species that are considered a medium to very high risk to the rainbow trout or endangered and native species downriver. NPS would plan to implement incentivized harvest for three winters prior to implementing other brown trout actions in the Glen Canyon reach. If triggered, other brown trout actions in the Glen Canyon reach would become available after October 31, 2022. If budget constraints, rapid and/or major changes in populations of brown trout or humpback chub, or other unexpected changes were identified, NPS would consult with AGFD and traditionally associated Tribes, communicate with the AWMG and TWG, and discuss if implementation of other actions are necessary sooner. NPS will plan to consult with AGFD and seek partners for planning and implementation of this action.
P.21 L.20	USFWS and NPS internal consistency – 2.2.2.2 Physical Controls - Dewatering with Pumps (Action P1; Tier 1).	Dewatering with Pumps (Action P1; Tier 1). Under this action, small off-channel ponds or backwaters would be dewatered to remove habitat for breeding non-native aquatic species and to remove all of the non-natives captured by mechanical removal, netting, or in the pump-filtration system. This Tier 1 action would be considered for use in small off-channel ponds and backwaters up to 0.5 ac in size. Use of one or more portable pumps with, for example, 3 in. to 4 in. discharge pipes capable of pumping up to 500 gallons per minute (gal/min) would be considered. Estimated time to drain a backwater would be 8 hr or less to reduce the effects of engine noise on wildlife and visitors and would not occur near sensitive areas (e.g., nesting raptors). If needed, the pumps would be used in conjunction with a temporary cofferdam in small backwater or off-channel areas connected to the river to quickly remove all of the non-native species.	Dewatering with Pumps (Action P1; Tier 1). Under this action, small off-channel ponds or backwaters would be dewatered for short periods of time (less than 2 weeks total) to remove habitat for breeding non-native aquatic species and to remove all of the non-natives captured by mechanical removal, netting, or in the pump-filtration system. This Tier 1 action would be considered for use in small off-channel ponds and backwaters up to 0.5 ac in size. Use of one or more portable pumps with, for example, 3 in. to 4 in. discharge pipes capable of pumping up to 500 gallons per minute (gal/min) would be considered. Estimated time to drain a backwater would typically be 8 hr or less, but in some circumstances it could be longer or require multiple efforts, but would not exceed 48 hr of pumping for any one action effort. NPS would try to minimize this time to reduce the effects of engine noise on wildlife and visitors and would not occur near sensitive areas (e.g., nesting raptors). Typically the dewatering period would be less than a week, however, in some circumstance the area may remain dewatered for a total of up to 2 weeks if there is a need to dry out small ponds or to stress eggs in the substrate. If needed, the pumps would be used in conjunction with a temporary cofferdam in small backwater or off-channel areas connected to the river to quickly remove a majority of the non-native species.

P.21 L.29	AGFD, Anglers concerns regarding a chemical treatment in RM-12 Sloughs – 2.2.2.2 Physical Controls - Dewatering with Pumps (Action P1; Tier 1).	Water pumped from the target area would be discharged to an adjoining backwater or other low-velocity area prior to the water re-entering the river main channel. Drying time may need to be adjusted if recent egg laying has occurred to fully desiccate any eggs remaining in the pond sediments. A treatment using a minimal amount of soda ash or other naturally occurring chemical may also be used if a small volume of water cannot be completely removed due to inflows from springs or the river to raise the pH above species-specific tolerance thresholds and ensure that no live fish or eggs remain. Prior to dewatering, NPS would remove fish from target habitats, relocate native fish to the main channel, and, in GCNRA only, evaluate potential non-lethal relocation of netted green sunfish to Lake Powell. NPS would plan for beneficial use of all other fish.	Water pumped from the target area would be discharged to an adjoining backwater or other low-velocity area prior to the water re-entering the river main channel. Drying time may need to be adjusted if recent egg laying has occurred to fully desiccate any eggs remaining in the pond sediments. A follow-up treatment under action C1 using a minimal amount of soda ash or other naturally occurring chemical may also be used if a small volume of water cannot be completely removed due to inflows from springs or the river to raise the pH above species-specific tolerance thresholds and ensure that no live fish or eggs remain. However, NPS intends to use these experimental treatments for research purposes and is experimenting with multiple methods with the intention of finding non-chemical actions in conjunction with this control action to reduce non-native reproduction. Prior to dewatering, NPS would remove fish from target habitats, relocate native fish to the main channel, and, in GCNRA only, evaluate potential non-lethal relocation of netted green sunfish to Lake Powell. NPS would plan for beneficial use of all fish that can be removed prior to the chemical treatment.
P.21 L.37	Based on USFWS consultation – 2.2.2.2 Physical Controls Dewatering with Pumps (Action P1; Tier 1).	In GCNRA, relocation of green sunfish to Lake Powell could occur if the fish to be removed are tested and found to be free of diseases, pathogens, and parasites; and state fish transport permits can be obtained. See Appendix C, Section C.2.2 for additional detail on live removal and relocation.	In GCNRA, relocation of green sunfish to Lake Powell could occur if the fish to be removed are tested and found to be free of diseases, pathogens, and parasites; and state fish transport permits can be obtained. See Appendix C, Section C.2.2 for additional detail on live removal and relocation. In addition, the pump intake pipe will have a metal screen to restrict gravel and for non-target fish uptake. All outflow will be screened to collect target species and ensure they do not enter other waters. Experimentation has shown very few target or non-target species are entrapped during pumping.
P.21 L.40	NPS Internal clarifications – 2.2.2.2 Physical Controls	Placement of Weirs or Barriers (Actions P2, P3; Tier 1). Selective weirs (Figure 2-2) may be put in place for specific time periods to disrupt spawning or restrict new invasions in backwaters and off-channel areas (< 5 ac in size), and tributaries. Selective weirs allow fish to be trapped and sorted. Weirs allow passage of water, but prevent fish movement. Fish are guided into a trap where they can be sorted by biologists; target non-native fish may be removed (and beneficial use would be pursued with Tribes) while non-target fish are released back into the target area. Non-selective barriers, including but not limited to nets, metal fish screens, or temporary cofferdams may be used to restrict non-native aquatic species access to backwaters and off-channel habitat areas. Barriers may also be used to restrict	Placement of Weirs or Barriers (Actions P2, P3; Tier 1). Selective weirs (Figure 2-2) may be put in place for specific time periods to disrupt spawning or restrict new invasions in backwaters and off-channel areas (< 5 ac in size), and tributaries. Selective weirs allow fish to be trapped and sorted. Weirs allow passage of water, but prevent fish movement. Fish are guided into a trap where they can be sorted by biologists; target non-native fish may be removed (and beneficial use would be pursued with Tribes) while non-target fish are released back into the target area. Non-selective barriers, such as nets, metal fish screens, barriers with concrete, wood or metal structure footings or anchors, or temporary cofferdams may be used to restrict non-native aquatic species access to backwaters and off-channel habitat areas. The actual barriers will be temporary and used typically for just part of the year, but the footers or other anchoring hardware may be left in place for years if needed. Barriers may also be used to restrict out-

		out-migration in areas where successful non-native spawning or congregating has already occurred and is found during monitoring efforts. In some circumstances, fish may not be captured, but movement is restricted while other actions are implemented.	migration in areas where successful non-native spawning or congregating has already occurred and is found during monitoring efforts. In some circumstances, fish may not be captured, but movement is restricted while other actions are implemented.
P.22 L.45	SNWA and Nevada – 2.2.2.2 Physical Controls Dredging to Connect the Upper Slough to the Lower Slough at RM -12 (Action P4; Tier 4).	This Tier 4 action would result in permanent habitat alteration, and would be used only if dewatering with pumps and Tier 2 and 3 actions are shown to be ineffective at controlling non-native aquatic species in the Upper Slough. Flows over approximately 21,000-23,000 cfs and up to 45,000 cfs may fill the small dredged channel with sediment or displace the headgate, thus, requiring periodic maintenance. Some mechanical removal would occur prior to draining to remove and relocate a majority of any non-target organisms present. Individuals of the target species would be collected previous to and during the treatment, where possible, for beneficial use to partially address Tribal concerns regarding the taking of life. Permitting through the U.S. Army Corps of Engineers (USACE) under Section 404 of the Clean Water Act may be required for dredging of the channel and installation of the water-control structure.	This Tier 4 action would result in permanent habitat alteration, and would be used only if dewatering with pumps and Tier 2 and 3 actions are shown to be ineffective at controlling non-native aquatic species in the Upper Slough. Flows over approximately 21,000-23,000 cfs and up to 45,000 cfs may fill the small dredged channel with sediment or displace the headgate, thus, requiring periodic maintenance. Best management practices would be used to avoid impacts to the wetlands (see Appendix C, section C.4 for more details). The construction period would be for a maximum of 2 weeks. Periodic dewatering using the headgate as a water control structure could last up to 2 weeks, dependent on if spawning has occurred and desiccation of eggs in the sediments is necessary. Refill and recovery of water quality/quantity conditions to normal is expected to occur within 7 days after the headgate is closed. To minimize effects to non-target fish and herpetiles, some mechanical removal would occur prior to draining to remove and relocate a majority of any non-target organisms present. Individuals of the target species would be collected using electrofishing and seine nets at the headgate structure previous to and during the treatment, where possible, for beneficial use to partially address Tribal concerns regarding the taking of aquatic life. Permitting through the U.S. Army Corps of Engineers (USACE) under Section 404 of the Clean Water Act (or Rivers and Harbors Act, and others as needed) may be required for dredging of the channel and installation of the water-control structure.
P.23 L.14	Clarifications based on USFWS consultation - 2.2.2.2 Physical Controls Produce Small Scale Temperature Changes to Adversely Affect Coldwater Non-Native Fish (Action P5; Experimental Outside of Tiers).	An initial experiment would be conducted on a small tributary (i.e., less than 10 cfs) prior to scaling up to Bright Angel Creek or other similar-size stream (approx. 25 cfs baseflow). This initial experiment would take place in summer, when warm air temperatures would help meet heating targets, and would elevate the water temperature for several weeks in a treatment reach from approximately 15°C (based on summer water temperature in upper Bright Angel Creek) to at least 22°C, which may be a critical threshold for young-of-year (YOY) brown trout. A target of as high as 29°C, a lethal threshold for adult brown trout (>350 mm total length), would be the maximum attempted temperature	An initial experiment would be conducted on a small tributary (i.e., less than 10 cfs) prior to scaling up to Bright Angel Creek or other similar-size stream (approx. 25 cfs base flow). This initial experiment would take place in summer, when warm air temperatures would help meet heating targets, and would elevate the water temperature over a period of 8 hr and maintain that elevated temperature for several weeks in a treatment reach from approximately 15°C (based on summer water temperature in upper Bright Angel Creek) to at least 22°C, which may be a critical threshold for young-of-year (YOY) brown trout. A target of as high as 29°C, a lethal threshold for adult brown trout (>350 mm total length), would be the maximum attempted temperature target. Initial experiments would target heating a 1,500 ft (457 m) stream segment for up to 6 weeks. Should this

		target. Initial experiments would target heating a 1,500 ft (457 m) stream segment. Should this small-scale experiment prove successful at eliminating trout (without harming native fishes and aquatic invertebrates), and if heating a larger volume of water is deemed feasible, it could be expanded to treat larger tributaries.	small-scale experiment prove successful at eliminating trout (without harming native fishes and aquatic invertebrates), and if heating a larger volume of water is deemed feasible, it could be expanded to treat larger tributaries.
P.23 L.26	Clarifications based on USFWS consultation and Jordan, Hamill, Strogen, and Persons, Anglers comments - 2.2.2.2 Physical Controls	Mechanical Disruption of Early Life Stage Habitats (Action M1; Tier 2). This Tier 2 action would use ongoing and new technologies to limit the success of spawning of high to very high risk species in known or suspected spawning beds. Mechanical disruption of spawning beds in shallow areas may include use of high-pressure water flushing, vacuum devices, or other mechanical gravel displacement to disturb the eggs and force them into the water column where they would be subject to higher predation rates.	Mechanical Disruption of Early Life Stage Habitats (Action M1; Tier 2). This Tier 2 action would use ongoing and new technologies to limit the success of spawning of high to very high risk species in known or suspected spawning beds. This would be an experimental action designed in cooperation and consultation with GCMRC and AGFD, and NPS would seek their partnership for implementation of this action. NPS would work with other agencies to ensure monitoring of the target non-natives (such as brown trout). This may involve various types of tagging or telemetry or other monitoring techniques to effectively map out spawning areas prior to using this action. In addition, because this is an experimental action, NPS may conduct one or several smaller pilot efforts before conducting a large implementation. Mechanical disruption of spawning beds may include use of high-pressure water flushing, vacuum devices, or other mechanical gravel displacement to disturb the eggs and force them into the water column where they would be subject to higher predation rates.
P.24 L.12	AGFD, Anglers comments on mechanical removal and NPS Internal clarifications - 2.2.2.2 Physical Controls - Mechanical Removal (Action M2; Tiers 1, 2, or 3).	Electrofishing has been used regularly in the Colorado River and its tributaries in Grand Canyon for over 25 years. Electrofishing is a preferred method for capturing fish because the mortality rate is lower than other methods (typically < 1%; Ainslie et al. 1998), and target non-native fish can be removed without harm to other fish populations (Bonar et al. 2009, Zale et al. 2012). Other removal methods such as chemicals or netting can have more harmful effects and do not allow for safe return of non-target species to the river. Other methods are used in situations where electrofishing has limitations, such as in very deep-water habitats, or habitats with dense vegetation where fish can hide. Electrofishing is less effective on smaller fish (Saunders et al. 2011) or eggs than other control methods. The effects to non-target species, such as rainbow trout, can be reduced further by using equipment settings designed to minimize impacts to that species (Sharber et al. 1994).	Electrofishing has been used regularly in the Colorado River and its tributaries in Grand Canyon for over 25 years. Electrofishing is a preferred method for capturing fish because the mortality rate is lower than other methods (typically < 1%; Ainslie et al. 1998), and target non-native fish can be removed without harm to other fish populations (Bonar et al. 2009, Zale et al. 2012). Experimental implementation of mechanical removal of trout at the confluence of the Colorado River and Little Colorado River from 2003 to 2006, was found to be effective for controlling trout populations (Coggins 2008; Coggins and Yard 2010). Other removal methods such as chemicals or netting can have more harmful effects and do not allow for safe return of non-target species to the river. Other methods are used in situations where electrofishing has limitations, such as in very deep-water habitats, or habitats with dense vegetation where fish can hide. Electrofishing is less effective on smaller fish (Saunders et al. 2011) or eggs than other control methods. The effects to non-target species, such as rainbow trout, will be reduced further by using equipment settings designed to minimize impacts to that species (Sharber et al. 1994) in most situations. In limited circumstances, such as backwaters where no rainbow trout or native fish are believed to be present based on pre-

			surveys, electrofishing or other electrical apparatus may be used with higher equipment settings to maximize the capture of target species.
P.24 L.34	Zuni sonic concussive concerns - 2.2.2.2 Physical Controls	Use of Sonic Concussion Devices (Action M3; Tier 4). This Tier 4 action could be used on medium to very high-threat species in backwater and off-channel habitat areas that are < 5 ac in size. This would be an experimental action as has been described in Gross et al. (2013), and would be implemented as a Tier 4 action. The equipment considered for this technique would be a pressure pulse cannon, or sonic cannon, which is not readily available commercially. Generally, the technique works by pulsing compressed gas (air) through the water column. This could be useful in smaller backwaters such as the Upper and Lower Sloughs at RM -12 to fully remove reproducing non-native aquatic species. It would be non-selective and could kill amphibians and non-target fish in the backwater. NPS would conduct mechanical removal prior to a treatment to remove and relocate as many of the non-target individuals as possible. Individuals of the target species would be collected pre- and post-treatment, where possible, for beneficial use to partially address Tribal taking of life concerns. No sonic concussive treatments would occur within 330 ft (100 m) of known locations of the endangered Kanab ambersnail.	Use of Acoustic Fish Deterrent and Guidance Devices (Action M3; Tier 1). This Tier 1 action could be used in backwater and off-channel habitat areas that are < 5 ac in size. This would be an experimental action; these devices are being tested by the U.S. Army Corps of Engineers, USGS, and others (USACE 2013, Noatch and Suski 2012, Vetter et al. 2016), and would be implemented as a Tier 1 action. The equipment considered for this technique would be fish guidance systems, acoustic deterrents, or bubblers used to guide non-native fish away from habitat areas where they may breed. These techniques work by creating low-intensity pressure waves in the water column and are non-lethal or at least have very low incidental mortality concerns if fish are allowed to move away from the source (USACE 2013). Such devices could be useful in smaller backwaters such as the area between the Upper and Lower Sloughs at RM-12 where a deterrent device might discourage non-native fish from moving from the Lower Slough into the Upper Slough, as well as from breeding in the warmer parts of the Lower Slough. Acoustic fish deterrent and guidance devices are likely to be non-selective and would discourage most fish from being in these areas, however coldwater species like trout are not generally entering or using these warmer backwaters and few native fish species have been found in the RM-12 slough area.
P.25 L.24	Clarifications based on USFWS consultation - 2.2.2.4 Biological Controls	All stocked YY-male fish would be marked, and public education for which fish should be released (i.e., marked YY males) and which should be kept and consumed (unmarked females and XY males). In GCNP, mechanical removal may be used concurrently with a YY-male experiment. Immigration of wild females from other sources could delay the effectiveness of this method.	All stocked YY-male fish would be marked, and public education for which fish should be released (i.e., marked YY males) and which should be kept and consumed (unmarked females and XY males). In GCNP, mechanical removal may be used concurrently with a YY-male experiment or to mitigate impacts if there is a reason to stop the experiment. Immigration of wild females from other sources could delay the effectiveness of this method.
P.25 L.32	Clarifications based on USFWS consultation, and addressing anglers concerns - 2.2.2.4 Biological Controls	Because this is an experimental method for which there may be a long delay (5 to 8 years) before stock becomes available, the latest scientific and field studies and any other new information regarding effectiveness and negative or unintended impacts would be reviewed prior to implementation. Additional planning and compliance may be considered if there was new information regarding potential impacts. Prior to implementation of this experiment, NPS would present any new information as well as details of the experimental implementation to relevant stakeholders and	Because this is an experimental method for which there may be a long delay (5 to 8 years) before stock becomes available, the latest scientific and field studies and any other new information regarding effectiveness and negative or unintended impacts would be reviewed prior to implementation. Additional planning and compliance may be considered if there was new information regarding potential impacts. Prior to implementation of this experiment, NPS would present any new information as well as details of the experimental implementation to AGFD and relevant stakeholders and Tribes, through the AMWG and TWG, and seek consensus. NPS may pilot test this action with a smaller

		Tribes, through the AMWG and TWG, and seek consensus. The life expectancy of brown trout and other target species should be considered prior to selecting this tool because it works best on short-lived species. Brown trout are known to live 10 to 20 years in the wild.	project in a tributary of GCNP prior to a larger experiment in GCNRA. The life expectancy of the non-native species to be introduced, their movements, population size, and the population sizes of endangered fish would be considered prior to implementation. Brown trout live for an average of 5 years with some individuals living for more than 10 years (NPS 2015b). See additional measures in Appendix C.
P.25 L.42	Addressing AGFD concerns regarding experimental chemical permitting and use, clarifications based on USFWS consultation, and angler and GCMRC comments - 2.2.2.5 Chemical Controls	Overwhelm Ecosystem Cycling Capabilities of Small Areas (Action C1; Tier 3). This Tier 3 action includes the possible use of ammonia, carbon dioxide, pH alteration, or oxygen super-saturation treatments and would be considered for small backwater and other off-channel areas (< 0.5 ac in size) where Tier 1 or 2 efforts have not been successful, periodic re-infestations and new spawning events continue to occur, use of Tier 3 and 4 tools like rotenone are a concern, and where environmental conditions are such that the use of these naturally occurring chemicals are expected to be successful in removing target non-native aquatic species. Prior to use, efforts would be made to remove a majority of the non-target species, especially natives, and to remove as many individuals of the target species so they could be relocated or provided for beneficial use. Use of approved methods to administer the chemicals and overwhelm the natural cycling or capacity of the small target area would be detailed in a treatment plan prepared prior to implementation. Depending on the amount of scientific literature on the treatment selected, the initial use of some of these tools may be conducted under research permits in conjunction with GCMRC staff or other scientists. Chemicals selected, efficacy whether in liquid or dry form, amounts used, application methods and timing, and monitoring would all be detailed in the treatment plan. A report on the results, including impacts on non-target species would also be made available to the TWG. NPS would consult with AGFD and other state agencies and seek state permits for implementation of this action as appropriate. NPS would not implement this action in the same location for more than five consecutive years. If this action is not effective as a long-term solution when implemented over a 5-year period, NPS would pursue additional planning and compliance for any subsequent actions not included within	Overwhelm Ecosystem Cycling Capabilities of Small Areas (Action C1; Tier 3). This Tier 3 action includes the possible use of ammonia, carbon dioxide, pH alteration, or oxygen-level alteration treatments and would be considered experimentally for small backwater and other off-channel areas (< 0.5 ac in size). This action would be designed with a primary focus for research purposes. NPS would coordinate with GCMRC and AGFD on the experimental design to test the effectiveness of these treatments, and NPS or its partners will obtain all applicable permits and approvals (typically ADEQ approval and ADAg R3-3-212 and 303 experimental use approval) prior to application. This action would be considered where Tier 1 or 2 efforts have not been successful, periodic re-infestations and new spawning events continue to occur, use of Tier 3 and 4 tools like rotenone are a concern, and where environmental conditions are such that the use of these naturally occurring chemicals are expected to be successful in removing target non-native aquatic species. Prior to use, efforts would be made to remove a majority of the non-target species, especially natives, and to remove as many individuals of the target species so they could be relocated or provided for beneficial use. Use of approved methods to administer the chemicals and overwhelm the natural cycling or capacity of the small target area would be detailed in a treatment plan prepared prior to implementation. Depending on the amount of scientific literature on the treatment selected, the initial use of some of these tools may be conducted under research permits in conjunction with GCMRC staff or other scientists. Chemicals selected, efficacy whether in liquid or dry form, amounts used, application methods and timing, and monitoring would all be detailed in the treatment plan. A report on the results, including impacts on non-target species would also be made available to the TWG. NPS will consult with AGFD and other state agencies and seek state permits for implementation of this action as appropriate. NPS would not implement this action in the same location for more than five consecutive years under this EA. If this action is not effective as a long-term solution when implemented over a 5-year period under this EA, NPS would pursue additional planning and compliance for any subsequent actions not included within this EA. All chemical use would be subject to

		this EA. All chemical use would be subject to NPS approval processes in strict adherence to applicable regulations and guidelines.	NPS approval processes in strict adherence to applicable regulations and guidelines.
P.26 L.17	NPS Internal clarifications regarding chemical treatment restrictions – 2.2.2.5 Chemical Controls	Application of Piscicides (Actions C2, C3, C4; Tier 3, 4, and 2, respectively). There are three situations when piscicides (i.e., chemicals that kill fish) could be used: (1) rapid response to invasion or sudden expansion of new species in backwaters and off-channel areas < 5 ac in size (Action C2, Tier 3); (2) control of high and very high-risk species in backwaters and off-channel areas < 5 ac in size (Action C3, Tier 4); and (3) tributary renovation (Action C4, Tier 2). NPS would not implement Action C3 in the same location for more than five consecutive years. If this action is not effective as a long-term solution when implemented over a 5-year period, NPS would pursue additional planning and compliance for any subsequent actions not included within this EA.	Application of Piscicides (Actions C2, C3, C4; Tier 3, 4, and 2, respectively). There are three situations when piscicides (i.e., chemicals that kill fish) could be used: (1) rapid response to invasion or sudden expansion of new species in backwaters and off-channel areas < 5 ac in size (Action C2, Tier 3); (2) control of high and very high-risk species in backwaters and off-channel areas < 5 ac in size (Action C3, Tier 4); and (3) tributary renovation (Action C4, Tier 2). NPS would not implement Action C3 in the same location for more than five consecutive years under this EA. If this action is not effective as a long-term solution when implemented over a 5-year period under this EA, NPS would pursue additional planning and compliance for any subsequent actions not included within this EA.
P.26 L.47	SNWA and Nevada – clarifications regarding chemical treatment restrictions – 2.2.2.5 Chemical Controls	Application of Herbicides (Action C5; Tier 1). Various registered herbicides may be used in backwater or off-channel areas < 5 ac in size to control highly invasive non-native aquatic plants and algae including weeds such as Eurasian watermilfoil, hydrilla, didymo, giant salvinia (Salvinia molesta), and Brazilian waterweed (Egeria densa). Non-toxic dyes may be used in combination with herbicide treatments to mark the areas treated. Chemicals would be used in compliance with NPS, federal, and state regulations, the manufacturer's label, safety data sheets, chemical transport and handling guidelines, and applicator certification requirements. The use of herbicides would be on a very limited basis and only when the threat was high for the targeted species to continue to spread and impact other critical aquatic habitat areas along the Colorado River. NPS would not implement this action in the same location for more than five consecutive years. If this action is not effective as a long-term solution when implemented over a 5-year period, NPS would pursue additional planning and compliance for any subsequent actions not included within this EA. All herbicide use would be subject to NPS approval processes in strict adherence to applicable regulations and guidelines.	Application of Herbicides (Action C5; Tier 1). Various registered herbicides may be used in backwater or off-channel areas < 5 ac in size or in tributaries to control highly invasive non-native aquatic plants and algae including weeds such as Eurasian watermilfoil, hydrilla, didymo, giant salvinia (*Salvinia molesta*), and Brazilian waterweed (*Egeria densa*). Non-toxic dyes may be used in combination with herbicide treatments to mark the areas treated. Chemicals would be used in compliance with NPS, federal, and state regulations, the manufacturer's label, safety data sheets, chemical transport and handling guidelines, and applicator certification requirements. The use of herbicides would be on a very limited basis and only when the threat was high for the targeted species to continue to spread and impact other critical aquatic habitat areas along the Colorado River. All herbicide use would be subject to NPS approval processes in strict adherence to applicable regulations and guidelines.

P.27 L.13	Sierra Club comment – 2.2.2.5 Chemical Controls	Application of Mollusk Repellents and Non-Toxic Antifouling Paints (Action C6; Tier 1). Repellents and antifouling paints would be applied to the exterior of boats, equipment used in the river, and NPS water intakes to reduce the threats and impacts from non-native aquatic mussels such as quagga mussels and Asian clam. NPS will carefully consider the use of any of these treatments and will ensure that they have also been approved by the state of Arizona. Current repellent treatments include the use of hot pepper capsaicin in a wax-based application. Approved anti-fouling paints for boat and equipment surfaces that do not utilize copper derivatives, which are toxic to aquatic organisms, or other toxic additives will be considered as new options are developed. All use of repellent and anti-fouling paint would be subject to NPS approval processes in strict adherence to applicable regulations and guidelines.	Application of Mollusk Repellents and Non-Toxic Antifouling Paints (Action C6; Tier 1). Repellents and antifouling paints would be applied to the exterior of boats, equipment used in the river, and NPS water intakes to reduce the threats and impacts from non-native aquatic mussels such as quagga mussels and Asian clam. NPS will carefully consider the use of any of these treatments and will ensure that they have also been approved by the state of Arizona. Current repellent treatments include the use of hot pepper capsaicin in a wax-based application, which may require re-application on an annual basis. Approved anti-fouling paints for boat and equipment surfaces that do not utilize copper derivatives, which are toxic to aquatic organisms, or other toxic additives will be considered as new options are developed. All use of repellent and anti-fouling paint would be subject to NPS approval processes in strict adherence to applicable regulations and guidelines.
P.27 L.29	Jordan, Hamill, Strogen, and Persons, Anglers comments regarding coordination with GCRMC and TWG – 2.2.3.1 - Control of Brown Trout in the Glen Canyon Reach	Control actions for brown trout in the Glen Canyon reach that are included under the Proposed Action are shown in Table 2-1. NPS would consult with and seek consensus with AGFD regarding the development and adaptation of triggers for these actions (see Appendix C, Sections C.1, C.2, and C.3 for additional details on triggers). At a minimum, NPS and AGFD would meet every 3 years to review triggers. This level of coordination is consistent with the 2013 Memorandum of Understanding between NPS and AGFD regarding cooperative management of the Lees Ferry fishery.	Control actions for brown trout in the Glen Canyon reach that are included under the Proposed Action are shown in Table 2-1. NPS would consult and seek consensus with AGFD regarding the development and adaptation of triggers for these actions (see Appendix C, Sections C.1, C.2, and C.3 for additional details on triggers). At a minimum, NPS and AGFD would meet every 3 years to review triggers. NPS would also consult with GCMRC and the TWG when changing triggers. This level of coordination is consistent with the 2013 Memorandum of Understanding between NPS and AGFD regarding cooperative management of the Lees Ferry fishery.
P.27 L.35	Sierra Club comment regarding 50% goal – 2.2.3.1 - Control of Brown Trout in the Glen Canyon Reach	Incentivized harvest (Action H1) is the Tier 1 action for brown trout control in the Glen Canyon reach as described in Section 2.2.2.1. The goal of incentive harvest programs would be to remove 25% to 50% of adult brown trout (>350 mm) and some juveniles from the population each year. As discussed in Section 2.2.2.1, NPS would plan to implement incentivized harvest for three winters prior to implementing other brown trout actions in the Glen Canyon reach. If triggered, other brown trout actions in the Glen Canyon reach would become available after October 31, 2021.	Incentivized harvest (Action H1) is the Tier 1 action for brown trout control in the Glen Canyon reach as described in Section 2.2.2.1. The goal of incentive harvest programs would be to remove 25% to 50% or higher of adult brown trout (>350 mm) and some juveniles from the population each year. As discussed in Section 2.2.2.1, NPS would plan to implement incentivized harvest for three winters prior to implementing other brown trout actions in the Glen Canyon reach. If triggered, other brown trout actions in the Glen Canyon reach would become available after October 31, 2022.
P.28 L.1	Anglers comment regarding effectiveness of mechanical removal - 2.2.3.1 Control of	Mechanical disruption of early life stage habitats at specific spawning sites (Action M1) is the Tier 2 action for brown trout control in the Glen Canyon reach as described in Section 2.2.2.3. Options for mechanical disruption include	Mechanical disruption of early life stage habitats at specific spawning sites (Action M1) is the Tier 2 action for brown trout control in the Glen Canyon reach as described in Section 2.2.2.3. Options for mechanical disruption include high-pressure water flushing and mechanical gravel

	Brown Trout in the Glen Canyon Reach	high-pressure water flushing and mechanical gravel displacement. Mechanical disruption for brown trout primarily would occur during spawning between November 1 and February 28 outside of the peak demand period for recreational fishing. This time period could be adjusted adaptively based on monitoring data or new research. Mechanical removal (Action M2) is the Tier 3 action for long-term control of brown trout in the Glen Canyon reach as described in Section 2.2.2.3. This action would be designed to maximize take of brown trout and minimize incidental take of rainbow trout, and would be triggered using the criteria in Table 2-1.	displacement. Mechanical disruption for brown trout primarily would occur during spawning between November 1 and February 28 outside of the typical peak demand period for recreational fishing (see Figure 3-1). This time period could be adjusted adaptively based on monitoring data or new research. Mechanical removal (Action M2) is the Tier 3 action for long-term control of brown trout in the Glen Canyon reach as described in Section 2.2.2.3. Experimental implementation of mechanical removal of trout at the confluence of the Colorado River and Little Colorado River from 2003 to 2006, was found to be effective for controlling trout populations (Coggins 2008; Coggins and Yard 2010) in that reach. This action would be designed to maximize take of brown trout and minimize incidental take of rainbow trout, and would be triggered using the criteria in Table 2-1.
P.28 L.14	SNWA and Nevada comment regarding population estimates - 2.2.3.1 Control of Brown Trout in the Glen Canyon Reach	In the Glen Canyon reach, electrofishing for mechanical removal of brown trout could be applied throughout the reach when the specific triggers are met, or in specific locations known as, or suspected of being spawning locations for brown trout or other target species. Reach-wide electrofishing for brown trout would be implemented similarly to the rainbow trout fishery monitoring work conducted by AGFD (Rogowski et al. 2015a, 2017). Up to eight complete electrofishing passes of the Glen Canyon reach would be conducted primarily between November 1 and February 28. Each pass could take up to 5 days to complete.	In the Glen Canyon reach, electrofishing for mechanical removal of brown trout could be applied throughout the reach when the specific triggers are met, or in specific locations known as, or suspected of being spawning locations for brown trout. Reach-wide electrofishing for brown trout would be implemented similarly to the rainbow trout fishery monitoring work conducted by AGFD (Rogowski et al. 2015a, 2017). Although there is uncertainty in any population estimate, population and uncertainty estimates from population models such as that used by Runge et al. (2018) and abundance estimates from AGFD monitoring activities would be considered to determine whether mechanical removal triggers for brown trout are met in any given year. NPS would work with GCMRC to ensure that the best available estimates for brown trout numbers are used to determine if triggers are exceeded. Up to eight complete electrofishing passes of the Glen Canyon reach would be conducted primarily between November 1 and February 28. Each pass could take up to 5 days to complete.
P.28 L.42	USFWS, AGFD and Anglers concerns regarding YY male action - 2.2.3.1 - Control of Brown Trout in the Glen Canyon Reach	Prior to implementation, NPS would review new modeling and field studies to determine if additional compliance was needed, and would consult with AGFD, GCMRC, FWS, Reclamation, Tribes, and relevant stakeholders, through the AMWG and TWG, to seek consensus. NPS retains decision-making authority as the action agency. NPS proposes a trigger level of > 500 adult brown trout (>350 mm) to begin stocking of YY-male brown trout in the Glen Canyon reach, and an initial annual stocking rate of	Prior to implementation, NPS would review new modeling and field studies to determine if additional compliance was needed, and would consult with AGFD, GCMRC, FWS, Reclamation, Tribes, and relevant stakeholders, through the AMWG and TWG, to seek consensus. NPS proposes an experimental stocking of YY-male brown trout in the Glen Canyon reach, with an initial annual stocking rate of 5,000 adult YY-male brown trout or 10,000 juveniles, which would, based on assumed juvenile survival rates, result in 5,000 adults after a few years. Stocking at this rate would continue for 10 years concurrently with continued

		5,000 adult YY-male brown trout or 10,000 juveniles, which would, based on assumed juvenile survival rates, result in 5,000 adults after several years. Stocking at this rate would continue for 10 years concurrently with continued incentivized harvest. These proposed trigger levels and stocking rates were set to limit the potential for outmigration and impacts on humpback chub, taking into account a range of concurrent removal rates and mortality rates for the stocked fish. Based on additional modeling or data, the annual stocking level could be adjusted adaptively by ± 4,000 adults (or equivalent number of juveniles). To evaluate effectiveness, wild age-0 brown trout would be tested for the presence of DNA from the stocked YY males. See Appendix C, Section C.3 for additional information on stocking YY-male brown trout in the Glen Canyon reach.	incentivized harvest. These proposed trigger levels and stocking rates were set to limit the potential for outmigration and impacts on humpback chub, taking into account a range of concurrent removal rates and mortality rates for the stocked fish. To evaluate effectiveness, wild age-0 brown trout would be tested for the presence of DNA from the stocked YY males. The NPS would likely conduct a smaller pilot test of the YY-male brown trout experiment in GCNP prior to this introduction in the mainstem. NPS would communicate with USFWS, AGFD, the AMWG, and TWG prior to implementation. See Appendix C, Section C.3 for additional information on stocking YY-male brown trout in the Glen Canyon reach.
P.29 L.22	WAPA and NPS Internal Clarification on dewatered times - 2.2.3.2 Control of Harmful Non-Native Aquatic Species in RM -12 Sloughs in the Glen Canyon Reach	Dewatering the Upper Slough periodically using high-volume portable pumps (Action P1) is one of the primary Tier 1 actions in the RM -12 sloughs as described in Section 2.2.2.2. The Upper Slough is a perched spring-fed pond above the elevation of the Lower Slough with refill rates of 3 to 8 gal/min). Prior to and during pumping, all non-target fish would be removed either with mechanical harvest or dip netting, and an attempt to collect and remove a majority of the target species would be made. Filters on pumps would collect any remaining target fish during the pumping. This method has advantages over other options because it is cost-effective, retains the spring-fed slough and related wetlands, and should be very effective for removing all targeted non-natives. To address Tribal concerns regarding the taking of life, NPS would attempt non-lethal removal and relocation of netted fish (only green sunfish transport and release to Lake Powell is currently being considered; see Section 2.2.2.3). If relocation were not possible, NPS would, to the extent possible, provide for beneficial use of removed fish (Section 2.2.2.3). Estimated refill times could be up to 2 weeks, which ensures that any eggs from spawning are dried out before the slough refills. It would also be possible to refill the slough more quickly by pumping water back into the slough from the river or Lower	Dewatering the Upper Slough periodically using high-volume portable pumps (Action P1) is one of the primary Tier 1 actions in the RM -12 sloughs as described in Section 2.2.2.2. The Upper Slough is a perched spring-fed pond above the elevation of the Lower Slough with refill rates of 3 to 8 gal/min). If non-native fish are found during regular monitoring and after any time flow has been >21,000 ft3/s [cfs] or as determined by monitoring), exclusion screens would be replaced, then pump-out would be initiated within 3 weeks after disconnection to 3 months depending on if green sunfish are reproducing (shorter time if reproducing). After the installation of new exclusion devices, monitoring will be conducted which may adjust the flow level up or down to ensure the trigger is activated when there is a substantial risk of green sunfish invading the Upper Slough. Prior to and during pumping, all non-target fish would be removed either with mechanical harvest or dip netting, and an attempt to collect and remove a majority of the target species would be made. Filters on pumps would collect any remaining target fish during the pumping. This method has advantages over other options because it is cost-effective, retains the spring-fed slough and related wetlands, and should be very effective for removing all targeted non-natives. To address Tribal concerns regarding the taking of aquatic life, NPS would attempt non-lethal removal and relocation of netted fish (only green sunfish transport and release to Lake Powell is currently being considered; see Section 2.2.2.3). If relocation were not possible, NPS would, to the extent possible, provide for beneficial use of removed fish (Section 2.2.2.3). Estimated dewatered times could be up to 2 weeks total. It would also be

		Slough should a concern or need arise to limit the impacts to the drained Upper Slough	possible to refill the slough more quickly by pumping water back into the slough from the river or Lower Slough should a concern or need arise to limit the impacts to the drained Upper Slough.
P.29 L.26	AGFD, anglers comments regarding permanent' or '100%' solutions - 2.2.3.2- Control of Harmful Non-Native Aquatic Species in RM -12 Sloughs in the Glen Canyon Reach		Other actions may be used in conjunction with Action P1. NPS intends to experiment and determine other actions that may work best in combination at this location to reduce or discourage breeding of green sunfish or other non-natives. NPS would like to use non-chemical and non-lethal actions if possible. NPS believes there is strong evidence for small numbers of green sunfish and other non-natives passing through the dam regularly and persisting in the river, so the expectation is not necessarily 100% elimination. Rather, the intention is to minimize the risk of downstream dispersal.
P.29 L.27	Zuni - 2.2.3.2- Control of Harmful Non-Native Aquatic Species in RM -12 Sloughs in the Glen Canyon Reach	Other Tier 1 actions that may be used in the RM-12 sloughs include placement of selective weirs (Action P2) and non-selective barriers (Action P3) as well as mechanical removal with beneficial use or possibly live relocation (Action M2). Under Action P2 and P3, a weir or barrier screen, respectively, would be placed between the Upper and Lower Sloughs and a barrier or net may be placed within the Lower Slough. These would be used to prevent migration or dispersal of targeted non-native fish from the Upper Slough.	Other Tier 1 actions that may be used in the RM-12 sloughs include placement of selective weirs (Action P2), non-selective barriers (Action P3), acoustic fish deterrent and guidance devices (Action M3), and mechanical removal with beneficial use or possibly live relocation of green sunfish (Action M2). Under Action P2 and P3, a weir or barrier screen, respectively, would be placed between the Upper and Lower Sloughs and a barrier or net may be placed within the Lower Slough. These would be used to prevent migration or dispersal of targeted non-native fish from the Upper Slough.
P.29 L.45	NPS internal consistency correction - 2.2.3.2-Control of Harmful Non-Native Aquatic Species in RM -12 Sloughs in the Glen Canyon Reach	Tier 3 actions in the RM-12 sloughs include overwhelming ecosystem cycling capabilities of the Upper Slough and possibly the much larger Lower Slough (Action C1) and rapid response application of registered piscicides for new invasive non-native fish that reproduce in either slough (Action C2) as described in Section 2.2.2.5 (Table 2-1). Action C2 would apply to any new harmful non-native aquatic species that is rated medium to very high risk, but would not apply to green sunfish in the Upper Slough, as they are no longer new in this area.	Tier 3 actions in the RM-12 sloughs include experimental treatments that would overwhelm ecosystem cycling capabilities of the Upper Slough and possibly the much larger Lower Slough (Action C1) and rapid response application of registered piscicides for new invasive non-native fish that reproduce in either slough (Action C2) as described in Section 2.2.2.5 (Table 2-1). Action C2 would apply to any new harmful non-native aquatic species that is rated medium to very high risk, but would not apply to green sunfish in the Upper Slough, as they are no longer new in this area.
P.30 L.4	Zuni sonic concussive concerns - 2.2.3.2- Control of Harmful Non-Native Aquatic Species in RM -12 Sloughs in the Glen Canyon Reach	Tier 4 actions in the RM-12 sloughs include dredging to re-connect the Upper Slough to Lower Slough (Action P4), sonic concussion treatment (Action M3), and application of experimental or registered piscicides for long-term control of high and very high-risk species (Actions C1 and C3) as described in Sections 2.2.2.2, 2.2.2.3, and 2.2.2.5, respectively. Long-term chemical control would be considered one of the last resorts and would be applied in the Lower Slough only for control of high and very high-risk	Tier 4 actions in the RM-12 sloughs include dredging to re-connect the Upper Slough to Lower Slough (Action P4), which includes a water control structure, and application of experimental or registered piscicides for long-term control of high and very high-risk species (Actions C1 and C3) as described in Sections 2.2.2.2, 2.2.2.3, and 2.2.2.5, respectively. Long-term chemical control would be considered one of the last resorts and would be applied in the Lower Slough only for control of high and very high-risk species if lower tier approaches failed. NPS would not implement Actions C1 or C3 in the same location for more than five

		species if lower tier approaches failed. NPS would not implement Actions C1 or C3 in the same location for more than five consecutive years. If this action is not effective as a long-term solution when implemented over a 5-year period, NPS would pursue additional planning and compliance for any subsequent actions not included within this EA.	consecutive years under this EA. If this action is not effective as a long-term solution when implemented over a 5-year period, NPS would pursue additional planning and compliance for any subsequent actions not included within this EA.
P.31 L.18	UCRC - 3.1 PROJECT AREA – added footnote 3	Regulated releases from Glen Canyon Dam and Lake Powell have resulted in an altered aquatic and terrestrial ecosystem compared to that which existed before Glen Canyon Dam.	Regulated releases from Glen Canyon Dam and Lake Powell have resulted in an altered aquatic and terrestrial ecosystem compared to that which existed before Glen Canyon Dam[3]. [3] Pre-dam conditions are discussed throughout this EA to provide historical and cumulative impact context for certain resources that exist in an already altered environment; however, such references are not intended to form the basis for comparison of direct and indirect effects of the alternatives, or to provide goals for achieving resource conditions. Rather, the Proposed Action is compared to the No-Action Alternative, as is the standard practice for National Environmental Policy Act of 1969 as amended (NEPA) compliance.
P.31 L.34	UCRC - 3.2.1 Water Quality—Affected Environment	Tributaries, backwaters, and off-channel areas tend to have higher temperatures than the Colorado River mainstem. Tributaries, especially the Paria River and Little Colorado River, carry large amounts of fine sediments and organic matter to the mainstem during flood events. The Little Colorado River contributes more salinity to the Colorado River than do other tributaries in the project area (DOI 2016a).	Tributaries, backwaters, and off-channel areas tend to have higher temperatures than the Colorado River mainstem. Tributaries, especially the Paria River and Little Colorado River, carry large amounts of fine sediments and organic matter to the mainstem during flood events. The construction of Glen Canyon Dam at Lake Powell has moderated salinity levels in both the reservoir and the tailwater (DOI 2016a).
P.32 L.9	UCRC - 3.2.2.1 Impacts of the No-Action Alternative on Water Quality	Under the No-Action Alternative, the proposed program of control actions would not occur, nor would associated water quality impacts; water quality would be unchanged from that described above in Section 3.2.1. The cumulative impacts of past, present, and reasonably foreseeable future actions on water quality have been significant and adverse (DOI 2016a; Appendix B, Table B-1). Past and present actions have reduced flow and resulted in alterations of water temperature and increases in salinity in the Colorado River. Climate change is expected to have the most significant effect on future changes in water temperature and quality. The No-Action Alternative would not contribute to cumulative impacts on water quality from past, present, and reasonably foreseeable future actions in the project area.	Under the No-Action Alternative, the proposed program of control actions would not occur, nor would associated water quality impacts; water quality would be unchanged from that described above in Section 3.2.1. Past and present actions, especially construction and operation of Glen Canyon Dam, have, reduced turbidity, and moderated salinity levels, and altered water temperature by moderating variation in the Colorado River downstream of the dam (DOI 2016a; Appendix B, Table B-1). Climate change is expected to have the most significant effects on future changes including changes to water temperature and quality, more rapid runoff and reduced flows as well as increasing evaporation in the system as ambient temperatures increase, and increased risks of extended drought (Vano et al. 2014, Mc Cabe et al, 2017, Mote et al. 2018, Xiao et a. 2018, Woodhouse et al. 2016, Ault et al. 2016, Melillo et al. 2014, Udall and Overpeck 2017). Future increases in population and development could

			increase diversions that reduce flows, or increase the potential for urban and agricultural runoff, which could have adverse effects on water quality (National Research Council. 2007, Reclamation 2012a). The No-Action Alternative would not contribute to cumulative impacts on water quality from past, present, and reasonably foreseeable future actions in the project area.
P.33 L.17	Hopi correction on herbicides being aquatic rather than terrestrial - 3.2.2.2 Impacts of the Proposed Action on Water Quality	Aquatic and terrestrial application of herbicides would likewise be subject to strict guidelines and controls to protect aquatic species and water quality, including NPS approval processes in strict adherence with applicable regulations and guidelines.	Aquatic application of herbicides would likewise be subject to strict guidelines and controls to protect aquatic species and water quality, including NPS approval processes in strict adherence with applicable regulations and guidelines.
P.33 L.23	Sierra Club comment clarifications - 3.2.2.2 Impacts of the Proposed Action on Water Quality	Mollusk repellents for use on boats and equipment used in the river contain capsaicin, an irritant and the hot spice found in chili peppers, incorporated in a wax base, which minimizes its release into water and the potential for impacts on non-target organisms. EPA notes in its pesticide reregistration summary for capsaicin that the agency relies on restrictive product label statements to minimize exposures and reduce any risks to aquatic species (EPA 1992). In addition, only non-toxic anti-fouling paints that do not contain copper and are approved for use in Arizona would be used for mollusk control. All use of repellent and anti-fouling paint would be subject to NPS approval processes in strict adherence to applicable regulations and guidelines.	Mollusk repellents for use on boats and equipment used in the river contain capsaicin, an irritant and the hot spice found in chili peppers. Current products incorporate capsaicin in a wax base, which minimizes its release into water and the potential for impacts on non-target organisms, but could require re-application on an annual basis. EPA notes in its pesticide reregistration summary for capsaicin that the agency relies on restrictive product label statements to minimize exposures and reduce any risks to aquatic species (EPA 1992). In addition, only non-toxic anti-fouling paints that do not contain copper and are approved for use in Arizona would be used for limiting the number of mollusks attaching to manmade items (i.e. insides of intake pipes, boat exteriors, etc.). All use of repellent and anti-fouling paint would be subject to NPS approval processes in strict adherence to applicable regulations and guidelines.
P.33 L.31	GCMRC comment - 3.2.2.2 Impacts of the Proposed Action on Water Quality	Chemical treatments to overwhelm natural cycling processes in small backwaters and off-channel areas for control of non-native aquatic species, by their nature, would temporarily affect the water quality of the treated waters. Such treatments would purposely change water quality parameter values outside of their natural range to create conditions unsuitable to targeted aquatic life. Treatments could include altering pH using ammonia or carbon dioxide, or super-saturation of water with oxygen. Such treatments would require confined water bodies to reach desired conditions, and thus would have limited potential for effects outside of the target area. Any treated water moving downstream would quickly dilute to within natural levels and thus would have very short range and temporary effects likely resulting in the avoidance of the area by mobile species, and no or very low incidental	Chemical treatments to overwhelm natural cycling processes in small backwaters and off-channel areas for control of non-native aquatic species, by their nature, would temporarily affect the water quality of the treated waters. Such treatments would purposely change water quality parameter values outside of their natural range to create conditions unsuitable to targeted aquatic life. Treatments could include altering pH using ammonia or carbon dioxide, or altering oxygen levels. Such treatments would require confined water bodies to reach desired conditions, and thus would have limited potential for effects outside of the target area. Any treated water moving downstream would quickly dilute to within natural levels and thus would have very short range and temporary effects likely resulting in the avoidance of the area by mobile species, and no or very low incidental mortality in non-target species. Reversing treatments and natural attenuation would quickly return affected areas to natural conditions.

		mortality in non-target species. Reversing treatments and natural attenuation would quickly return affected areaas to natural conditions.	
P.33 L.41	UCRC comments - 3.2.2.2 Impacts of the Proposed Action on Water Quality	The cumulative impacts of past, present, and reasonably foreseeable future actions on water quality have been significant and adverse (DOI 2016a; Appendix B, Table B-1). Past and present actions have reduced flow and resulted in alterations of water temperature and increases in salinity in the Colorado River. Climate change is expected to have the most significant effect on future changes in water temperature and quality. The Proposed Action would result in incremental changes to water quality (mostly turbidity and some contaminants) that would be limited to the areas where control actions would occur. Interaction and accumulation of adverse impacts on water quality from multiple control actions would be limited because (1) most individual actions and their effects would persist for less than a week, (2) most actions would occur in small (< 5 ac) habitats that are isolated from the main channel and each other, and (3) tiered implementation of actions would reduce the potential for different actions to occur simultaneously at specific locations. No change in baseline water quality conditions are expected.	Past and present actions, especially construction and operation of Glen Canyon Dam, have reduced turbidity, and moderated salinity levels, and altered water temperature regimes b moderating variation in the Colorado River downstream of the dam (DOI 2016a; Appendix B, Table B-1). Climate change is expected to have the most significant effects on future changes including changes to water temperature and quality, more rapid runoff and reduced flows as well as increasing evaporation in the system as ambient temperatures increase, and increased risks of extended drought (Vano et al. 2014, Mc Cabe et al, 2017, Mote et al. 2018, Xiao et a. 2018, Woodhouse et al. 2016, Ault et al. 2016, Melillo et al. 2014, Udall and Overpeck 2017). Future increases in population and development could increase diversions that reduce flows, or increase the potential for urban and agricultural runoff, which could have adverse effects on water quality (National Research Council. 2007, Reclamation 2012a). The Proposed Action would result in incremental changes to water quality (mostly short-term increases in turbidity and some contaminants if chemical controls are used) that would be limited to the areas where control actions would occur. Interaction and accumulation of adverse impacts on water quality from multiple control actions would be limited because (1) most individual actions and their effects would persist for less than a week, (2) most actions would occur in small (< 5 ac) habitats that are isolated from the main channel and each other, and (3) tiered implementation of actions would reduce the potential for different actions to occur simultaneously at specific locations. No change in baseline water quality conditions are expected.
P.35 L.32	Hopi comment regarding trout management differences - 3.3.1.3 Native Fish and Special Status Fish Species	Introductions of non-native fish species also have affected native fish in the Colorado River and its tributaries. Brown trout in the Glen Canyon reach have increased from 2014–2016 raising concerns regarding potential impacts on native fish, especially humpback chub near the Little Colorado River (Runge et al. 2018). Details regarding the status, biology, and threats to the native fish community in the project area are provided in Appendix E and the LTEMP EIS (DOI 2016a).	Introductions of non-native fish species also have affected native fish in the Colorado River and its tributaries. Control actions have been used for several years to reduce the numbers of brown and rainbow trout in Bright Angel Creek and in the vicinity of the Little Colorado River confluence because of the threat they pose to native fish in GCNP (Healy et al. 2018). Brown trout in the Glen Canyon reach have increased from 2014–2016 raising concerns regarding potential impacts on native fish, especially humpback chub near the Little Colorado River (Runge et al. 2018). Details regarding the status, biology, and threats to the native fish community in the project area are provided in Appendix E and the LTEMP EIS (DOI 2016a).
P. 36 L.4	Hualapai comment.	Species: Humpback chub (Gila cypha)	Species: Humpback chub (Gila cypha)

	Table 3-1.	Listing Status: ESA-E, CH; AZ-SGCN Presence in Vicinity of Project Area: Lake Powell, Paria River confluence to Separation Canyon, Little Colorado River, Havasu Creek, Bright Angel Creek	Listing Status: ESA-E, CH; AZ-SGCN Presence in Vicinity of Project Area: Lake Powell, Paria River confluence to Pearce Ferry, Little Colorado River, Havasu Creek, Bright Angel Creek
P.36 L.3	Hopi and AGFD clarification regarding Table F-1 reference - 3.3.1.4 Non-Native Fish	medium-high to very high level of threat and seven species (black bullhead [Ameiurus melas], black crappie [Pomoxis nigromaculatus], bluegill [Lepomis macrochirus], common carp [Cyprinus carpio], channel catfish [Ictalurus punctatus], yellow bullhead [Ameiurus natalis], and red shiner [Cyprinella lutrensis]) pose a medium-low to medium level of threat to native aquatic species. Rainbow trout pose a low level of threat in the Glen Canyon reach, where they are managed to support a recreational trout fishery, but are considered to pose a high-level of threat in Grand Canyon National Park where the emphasis is on native fish conservation (Table F-1).	medium-high to very high level of threat and seven species (black bullhead [*Ameiurus melas*], black crappie [*Pomoxis nigromaculatus*], bluegill [*Lepomis macrochirus*], common carp [*Cyprinus carpio*], channel catfish [*Ictalurus punctatus*], yellow bullhead [*Ameiurus natalis*], and red shiner [*Cyprinella lutrensis*]) pose a medium-low to medium level of threat to native aquatic species. Rainbow trout pose a low level of threat in the Glen Canyon reach, where they are managed to support a recreational trout fishery, but are considered to pose a higher level of threat in Grand Canyon National Park where the emphasis is on native fish conservation.
P.38 L.10	AGFD, Hopi and anglers comments regarding brown trout - 3.3.2.1 Impacts of the No-Action Alternative on Aquatic Resources	Population estimates based on catch-per-unit effort and mark-recapture data indicated that approximately 6,000 brown trout over 350 mm in length were present in the Glen Canyon reach in 2017 (Runge et al. 2018). Modeling conducted by Runge et al. (2018) suggests that, under the No-Action Alternative (status quo), there would be a 64% likelihood that the abundance of brown trout within the Glen Canyon reach would increase by 3 to 10 times and could reach 80,000 adults (mean of 16,000) over the next 20 years. Modeling indicated that the minimum adult humpback chub population could decrease considerably as the abundance of brown trout in the Glen Canyon reach increases. Modeling showed impacts on the humpback chub population at the Little Colorado River when there were as few as 5,000 adult brown trout, and that impacts would increase as the brown trout population increases.	Brown trout have been collected in low numbers in the Glen Canyon reach for several decades during AGFD fish monitoring activities. However, increases in catch-per-unit effort of brown trout during AGFD monitoring and indications of increased brown trout spawning during a mark-recapture study (Korman et al. 2016) were observed over the period from 2014 to 2016. Population estimates based on catch-per-unit effort and mark-recapture data indicated that approximately 6,000 brown trout over 350 mm in length were present in the Glen Canyon reach in 2017 (Runge et al. 2018). Modeling conducted by Runge et al. (2018) suggests that, under the No-Action Alternative (status quo), there would be a 64% likelihood that the abundance of brown trout within the Glen Canyon reach would increase by 3 to 10 times and could reach 80,000 adults (mean of 16,000) over the next 20 years. Modeling also indicated that the minimum adult humpback chub population could decrease considerably as the abundance of brown trout in the Glen Canyon reach increases (Runge et al. 2018). Modeling identified potential impacts on the humpback chub population at the Little Colorado River when there were as few as 5,000 adult brown trout in the Glen Canyon reach, and that impacts would increase as the brown trout population increases (Runge et al. 2018).
P.38 L.38	UCRC - 3.3.2.1 Impacts of the No-Action Alternative on Aquatic Resources - Cumulative Impacts of	Significant, mostly adverse cumulative impacts on aquatic resources in the project area primarily result from changes in seasonal and annual flow patterns. Past, present, and reasonably foreseeable future actions and trends have or are expected to produce increased water demand (resulting from	Significant, mostly adverse cumulative impacts on aquatic resources in the project area primarily result from the presence of the dam, however there have been successive changes in seasonal and annual flow patterns since construction that have partially moderated those impacts (DOI 2016a). Past, present, and reasonably foreseeable future actions and trends have or

	the No-Action Alternative	population growth and development); decreased water supply (resulting from drought and increased water temperature attributed to climate change); and other foreseeable actions (DOI 2016a; see Appendix B, Table B-1). Decreases in runoff, reservoir volume, and river flow caused by drought and increased demand would result in lower reservoir elevations and warmer release temperatures, which could benefit native aquatic species, but also make conditions more favorable for warmwater non-native aquatic species that prey on or compete with native species.	are expected to produce increased water demand (resulting from population growth and development) and decreased water supply (resulting from drought and increased water temperature attributed to climate change) (DOI 2016a; see Appendix B, Table B-1). Future increases in population and development could increase diversions that reduce flows, or increase the potential for urban and agricultural runoff, which could have adverse effects on water quality (National Research Council. 2007, Reclamation 2012a). Decreases in runoff, reservoir volume, and river flow caused by drought and increased demand would result in lower reservoir elevations and warmer release temperatures, which could benefit native aquatic species, but also make conditions more favorable for warmwater non-native aquatic species that prey on or compete with native species.
P.42 L.12	NPS internal clarification, 3.3.2.1 Impacts of the No-Action Alternative on Aquatic Resources - Dredging to Connect the Upper Slough to the Lower Slough at RM -12	**Dredging to Connect the Upper Slough to the Lower Slough at RM -12 (Action P4; Tier 4)** This option is a more permanent alteration of the Upper Slough compared to periodic dewatering using pumps. Reclamation estimated that 200 yd3 of gravel and cobble substrate would need to be excavated to create a connecting channel approximately 3 ft wide and 300 ft long (Option 6.2 in Greimann and Sixta 2018). In addition, there would be a potential for habitat disturbance from barging equipment, fuel, and personnel to and from the area from the nearest landing. Dredging would result in the disturbance of substrate supporting benthic habitats and increased turbidity in the immediate project area during the dredging period, which is expected to take up to two weeks. Recovery following completion of the action is expected to occur rapidly (within 10 to 30 days), and the composition of the substrate after completion of dredging would remain similar to pre-dredging conditions. Algae and benthic organisms displaced during dredging would likely recolonize affected areas within weeks to months, depending on season. Drying of substrate when the Upper Slough is drained may result in decreases in production of algae and aquatic invertebrates, again depending on season. However, once the headgate structure between the Upper and Lower Sloughs is closed and the slough fills, recovery of aquatic productivity would be expected.	**Dredging to Connect the Upper Slough to the Lower Slough at RM -12 (Action P4; Tier 4)** This option is a more permanent alteration of the Upper Slough compared to periodic dewatering using pumps. Reclamation estimated that 150 yd3 of gravel and cobble substrate would need to be excavated to create a connecting channel approximately 3 ft wide and 300 ft long (Option 6.2 in Greimann and Sixta 2018). In addition, there would be a potential for habitat disturbance from barging equipment, fuel, and personnel to and from the area from the nearest landing. Dredging would result in the disturbance of substrate supporting benthic habitats and increased turbidity in the immediate project area during the dredging period, which is expected to take up to two weeks. Refill and recovery of water quality conditions following completion of the action is expected to occur rapidly (within 7 days), and the composition of the substrate (primarily gravel) after completion of dredging would remain similar to pre-dredging conditions. Algae and benthic organisms displaced during dredging would likely recolonize affected areas within weeks to months, depending on season. Drying of substrate when the Upper Slough is drained may result in decreases in production of algae and aquatic invertebrates, again depending on season. However, once the headgate structure between the Upper and Lower Sloughs is closed and the slough fills, recovery of aquatic productivity would be expected. The drying and impacts to invertebrates and wetland vegetation on the fringe of the Upper Slough would be localized and temporary, and the natural wetland processes, functions, and values would be retained, so there would be no loss of wetlands expected from action P4.

P.43 L.16	AGFD comment questioning comparison to HFE - 3.3.2.2 Impacts of the Proposed Action on Aquatic Resources - Mechanical Disruption of Early Life Stage Habitats (Action M1; Tier 2)	Mechanical disruption of spawning substrates by flushing with high-pressure water, mechanical displacement of gravel, or placement of temporary electrical grids or substrate covers (primarily from November 1 through February 28 for brown trout) would result in localized disturbance of aquatic habitat. Although the timing would be different, it is expected that the overall amount of disturbance from flushing or mechanical displacement of substrates within treated areas would be no greater than the effects of HFEs. Potential adverse impacts on spawning native fish and rainbow trout later in the year would be reduced because gravels would be returned to their place of origin during the treatment. Substrate disturbance would be less if electrical grids or substrate covers were used. Algae and benthic organisms displaced during treatments would likely recolonize affected areas within days to months after the treatment has been completed, depending upon the season of the year	Mechanical disruption of spawning substrates by flushing with high-pressure water, mechanical displacement of gravel, or placement of temporary electrical grids or substrate covers (primarily from November 1 through February 28 for brown trout) would result in localized disturbance of aquatic habitat. Potential adverse impacts on spawning native fish and rainbow trout later in the year would be reduced because gravels would remain or be returned to their approximate place of origin during the treatment. Substrate disturbance would be less if electrical grids or substrate covers were used. Algae and benthic organisms displaced during treatments would likely recolonize affected areas within days to months after the treatment has been completed, depending upon the season of the year
P.43 L.42	Jordan, Hamill, Strogen, and Persons, Anglers comments - 3.3.2.2 Impacts of the Proposed Action on Aquatic Resources - Mechanical Disruption of Early Life Stage Habitats (Action M1; Tier 2)	Mechanical disruption of early life stage habitat might be effective for controlling recruitment of small populations with spatially and temporally restricted spawning areas. For larger and more widespread populations, a population-level response would only be likely if nearly all spawning areas could be identified and a large proportion of eggs or larvae were affected by treatments.	Mechanical disruption of early life stage habitat might be effective for controlling recruitment of small populations with spatially and temporally restricted spawning areas. For larger and more widespread populations, a population-level response would only be likely if nearly all spawning areas could be identified and a large proportion of eggs or larvae were affected by treatments. In addition, there is a possibility that overall population-level decreases may not occur if reduced survival of eggs and larvae in disrupted spawning areas resulted in compensatory increases in survival rates and recruitment for remaining eggs and larvae individuals. For example, Korman et al. (2011) found that increased incubation mortality of rainbow trout in Glen Canyon due to flow fluctuations appeared to be offset by compensatory survival responses.
P.44 L.42	Anglers comments regarding other case studies of mechanical removals - Mechanical Removal (Action M2; Tiers 1, 2, or 3) – 3.3.2.2 Impacts of the Proposed Action on Aquatic Resources	There are many examples of mechanical removal techniques being used to reduce the abundance of non-native aquatic species, with varying degrees of success (e.g., Franssen et al. 2014, Healy et al. 2018; Mueller 2005; Meronek et al. 1996; Meyer et al. 2017; Zelasko et al. 2016). Mechanical removal methods are most likely to be effective for eliminating or reducing small populations of non-native species that are concentrated in specific locations. For larger and more widespread populations, a population-level response would only be likely if a large proportion of	There are many examples of mechanical removal techniques being used to reduce the abundance of non-native aquatic species, with varying degrees of success (e.g., Franssen et al. 2014, Healy et al. 2018; Mueller 2005; Meronek et al. 1996; Meyer et al. 2017; Zelasko et al. 2016). Mechanical removal methods are most likely to be effective for eliminating or reducing small populations of non-native species that are concentrated in specific locations. For larger and more widespread populations, a population-level response would only be likely if a large proportion of individuals can be removed. Intensive electrofishing in the Satilla River was successful at maintaining reduced numbers of flathead catfish

		individuals can be removed. Runge et al (2018) used modeling to evaluate the potential for mechanical removal (electrofishing) to affect brown trout populations in the Glen Canyon reach and concluded that 8 annual removal passes that targeted the largest and most reproductively successful brown trout during the spawning period could reduce median brown trout abundance over a 20-year period by about 50% compared to a status quo scenario.	(*Pylodictis olivaris*) (Bonvechio et al. 2011). Although mechanical removal of northern pike in the Yampa River of the Upper Colorado River basin resulted in lower numbers of large individuals, the northern pike population was expected to recover once control efforts were discontinued (Zelasko et al. 2016). Runge et al (2018) used modeling that considered capture rates from AGFD electrofishing monitoring between 2000 and 2017 to evaluate the potential for mechanical removal (electrofishing) to affect brown trout populations in the Glen Canyon reach and concluded that 8 annual removal passes that targeted the largest and most reproductively successful brown trout during the spawning period could reduce median brown trout abundance over a 20-year period by about 50% compared to a status quo scenario.
P.45 L.5	Anglers comments on mechanical removal efficacy- Mechanical Removal (Action M2; Tiers 1, 2, or 3) – 3.3.2.2 Impacts of the Proposed Action on Aquatic Resources	The potential for benefits to native aquatic species of this action would depend on its effectiveness in suppressing populations of non-native fishes. There is evidence that reducing the abundance of non-native species from specific habitat areas can result in improvements in survival and recruitment of native fishes. Efforts to remove non-native fishes in Bright Angel Creek during 2012-2017 sufficiently suppressed trout numbers to allow for enhanced recruitment of native fishes (Healy et al. 2018). Runge et al. (2018) modeled the potential for mechanical removal of brown trout in the Glen Canyon reach (see previous paragraph) to affect humpback chub populations in downstream reaches and concluded that mechanical removal of brown trout could slightly increase the median minimum abundance of adult humpback chub.	The potential for benefits to native aquatic species of this action would depend on its effectiveness in suppressing populations of non-native fishes. There is evidence that reducing the abundance of non-native species from specific habitat areas can result in improvements in survival and recruitment of native fishes. Removal of nonnative fish from a 4.9 km reach of the West Fork Gila River resulted in population benefits to some native fish species (Propst et al. 2014) and efforts to remove non-native fishes in Bright Angel Creek during 2012-2017 sufficiently suppressed trout numbers to allow for enhanced recruitment of native fishes (Healy et al. 2018). Runge et al. (2018) modeled the potential for mechanical removal of brown trout in the Glen Canyon reach (see previous paragraph) to affect humpback chub populations in downstream reaches and concluded that mechanical removal of brown trout could slightly increase the median minimum abundance of adult humpback chub.
P.45 L.28	Zuni sonic concussive concerns - 3.3.2.2 Impacts of the Proposed Action on Aquatic Resources	Use of Sonic Concussion Devices (Action M3; Tier 4) Depending on the design of the pressure pulse cannon, fishes up to approximately 30 ft from the source of the pulses could be killed due to internal tissue damage (Gross et al. 2013). Pulsed pressure waves can be lethal to adults, eggs and larvae, although larval fishes are less sensitive than older fishes in which the swim bladder has developed (Wright 1982). The lethality of pulsed pressure waves varies with fish size, species, orientation of individual fish relative to the shock wave, intensity and frequency of pressure waves, water depth, target depth, and bottom type (Gross et al 2013; Wright 1982). Pulsed pressure waves are not expected to	Use of Acoustic Fish Deterrent and Guidance Devices (Action M3; Tier 1) Acoustic fish deterrent and guidance devices are designed to repel fish from target areas and guide them elsewhere. This tool would be deployed to repel non-native fish from suitable breeding habitat, such as warmwater natives from warm backwater habitats where they could reproduce. Acoustic fish deterrent and guidance devices are intended to be non-lethal tools and any incidental mortality should be very low (USACE 2013). Acoustic fish deterrent and guidance devices may also repel non-target fish or amphibians and prevent their use of target areas, however the use of acoustic guidance would be limited to small backwaters or ponds < 5 ac. These devices may also require some limited disturbance at the shoreline for installation of generators or solar panels to power the devices.

		adversely affect substrates or other components of habitats in target areas. Any non-native aquatic species present in backwaters, or off-channel ponds within the project area could be targeted by this control action. Gross et al (2013) found that about 96% of northern pike exposed to pulsed pressure waves in a field experiment had tissue damage that was likely to be fatal and that 31% had died within 7 days after exposure. Thus, repeated treatment of small backwaters or ponds over one or more days would likely be effective at reducing abundance of non-native species. There is a potential that a similar approach could be used to target spawning areas and reduce survival of eggs and larvae within these same habitats. Overall, treatment with pulsed pressure waves could benefit native aquatic species by eliminating or controlling expansion of a non-native species within the project area. The potential for benefits to native aquatic species would depend upon the effectiveness of the control action for suppressing populations of targeted non-native fishes. It is likely that pulsed pressure waves would also harm individuals of non-target species, including native species or rainbow trout that may be present in treated habitats. As described in Section 2.2.2.3, pre-treatment surveys would be conducted and native aquatic species would be mechanically removed and relocated to nearby aquatic habitats or returned to the treated location after treatment has been completed. In GCNRA only, NPS would evaluate potential non-lethal relocation of green sunfish to Lake Powell and would plan for beneficial use of all other non-native fish. Relocation of green sunfish to Lake Powell could occur if the fish to be removed are tested and found to be free of diseases, pathogens, and parasites; and state fish transport permits can be obtained (Appendix C, Section C.2). Impacts on the small number of rainbow trout potentially affected by using pulsed pressure waves in the RM -12 sloughs would not have a measurable effect on the rainbow trout population or the trout fishery in the Glen Canyon reach.	This action would not have a measurable effect on the rainbow trout population or the trout fishery in the Glen Canyon reach and should not have any measurable effects on endangered fish.
P.46 L.40	USFWS clarification regarding individuals versus species -	Mechanical harvesting of dense patches of aquatic plants has a potential to harm some non-target species, including native fish species or rainbow trout that may be using the	Mechanical harvesting of dense patches of aquatic plants has a potential to harm some non-target species, including native fish species or rainbow trout that may be using the vegetation as refuge or feeding areas.

	Mechanical Harvesting of Non-Native Plants and Algae (Action M4; Tier 1) – 3.3.2.2 Impacts of the Proposed Action on Aquatic Resources	vegetation as refuge or feeding areas. Haller et al. (1980) found that mechanical harvesting of hydrilla in Florida entangled substantial numbers of fishes in the cut vegetation. Therefore, the potential presence of native aquatic species should be considered prior to harvesting aquatic plants within the project area. To the extent practicable, any native fish and rainbow trout entangled during mechanical harvesting would be returned to the waterbody, but could be injured or killed in the process. The number of fish entangled during mechanical harvesting is expected to be small because fish are more likely to avoid the area when the removal begins. The small number of rainbow trout potentially affected by mechanical harvesting of plants in the RM -12 sloughs would not have a measurable effect on the rainbow trout population or the trout fishery in the Glen Canyon reach.	Haller et al. (1980) found that mechanical harvesting of hydrilla in Florida entangled substantial numbers of fishes in the cut vegetation. Therefore, the potential presence of native aquatic species should be considered prior to harvesting aquatic plants within the project area. To the extent practicable, any native fish and rainbow trout entangled during mechanical harvesting would be returned to the waterbody, but some individuals may be injured or killed in the process. The number of fish entangled during mechanical harvesting is expected to be small because fish are more likely to avoid the area when the removal begins. The small number of rainbow trout potentially affected by mechanical harvesting of plants in the RM -12 sloughs would not have a measurable effect on the rainbow trout population or the trout fishery in the Glen Canyon reach.
P.47 L.24	USFWS comments on model consistency with other stocking models - Introduction of YY-Male Fish (Action B1, Experimental) - 3.3.2.2 Impacts of the Proposed Action on Aquatic Resources	A model developed by the GCMRC and FWS to evaluate the impact of stocking rainbow trout on humpback chub was modified to estimate how stocking YY-male brown trout in the Glen Canyon reach might contribute to mortality of juvenile humpback chub in the Little Colorado River reach of the Colorado River (Appendix C, Section C.3.3). Annual stocking would be limited initially to a maximum of 5,000 adult YY-male brown trout, or an equivalent number of juveniles (estimated to be 10,000 based on assumed juvenile survival rates). This number represents a conservative level of risk to humpback chub if brown trout survival, movement, and predation rates are at high-risk levels. This maximum stocking number could be adjusted adaptively by ± 4,000 adults (or equivalent juveniles) based on additional modeling or data. Modeling indicated that annual stocking of 5,000 adult YY-male brown trout into the Glen Canyon reach for a 10-year period could result in average annual consumption over a 20-year period of 13, 169, and 3,813 juvenile humpback chub under low-, moderate-, and high-risk scenarios, respectively. Total consumption of juvenile humpback chub over the 20-year period was estimated to be 269, 3,379, and 76,259 for the low-, moderate-, and high-risk scenarios, respectively (see Appendix C, Section C.3.3). Estimated YOY humpback chub production in the Little	A model developed by the GCMRC and FWS to evaluate the impact of stocking rainbow trout on humpback chub was modified to estimate how stocking YY-male brown trout in the Glen Canyon reach might contribute to mortality of juvenile humpback chub in the Little Colorado River reach of the Colorado River (Appendix C, Section C.3.3). Annual stocking would be limited initially to a maximum of 5,000 adult YY-male brown trout, or an equivalent number of juveniles (estimated to be 10,000 based on assumed juvenile survival rates). This number represents a conservative level of risk to humpback chub if brown trout survival, movement, and predation rates are at high-risk levels. Wild brown trout live for an average of 5 years with some individuals living more than 10 years (NPS 2015b). Survival of introduced YY males would be expected to be lower than that, but the modeling considered a range of survival levels. Modeling indicated that annual stocking of 5,000 adult YY-male brown trout into the Glen Canyon reach for a 10-year period could result in average annual consumption over a 20-year period of 13, 113, and 1,915 juvenile humpback chub under low-, moderate-, and high-risk scenarios, respectively. Total consumption of juvenile humpback chub over the 20-year period was estimated to be 269, 2,254, and 38,301 for the low-, moderate-, and high-risk scenarios, respectively (see Appendix C, Section C.3.3). Estimated YOY humpback chub production in the Little Colorado River ranges from approximately 5,000 to 45,000 per year (Yackulic 2018b). Based on these estimates, stocked brown trout could consume up to 76% of a year's production in some low humpback chub

		Colorado River ranges from approximately 5,000 to 45,000 per year (Yackulic 2018b). Based on these estimates, stocked brown trout could consume the entire year's production in some low humpback chub production years and up to 17% of the YOY humpback chub could be consumed in high production years.	production years and up to 8% of the YOY humpback chub could be consumed in high production years.
P.48. L.8	NPS internal clarification - 3.3.2.2 Impacts of the Proposed Action on Aquatic Resources	Overwhelm Ecosystem Cycling Capabilities of Small Areas (Action C1; Tier 3) The use of chemical treatments to overwhelm the ability of backwaters and off-channel ponds (< 5 ac in size) to support non-native species by altering ecosystem cycling capabilities (Section 2.2.2.5) would not disturb substrates in treated habitats, but would temporarily affect water quality (Section 3.2.2).	Overwhelm Ecosystem Cycling Capabilities of Small Areas (Action C1; Tier 3) The use of chemical treatments to overwhelm the ability of small backwaters and off-channel ponds (< 0.5 ac in size) to support non-native species by altering ecosystem cycling capabilities (Section 2.2.2.5) would not disturb substrates in treated habitats, but would temporarily affect water quality (Section 3.2.2).
P.48 L.20	NPS internal clarification - Overwhelm Ecosystem Cycling Capabilities of Small Areas (Action C1; Tier 3) 3.3.2.2 Impacts of the Proposed Action on Aquatic Resources	NPS would not implement this action in the same location for more than five consecutive years. If this action is not effective as a long-term solution when implemented over a 5-year period, NPS would pursue additional planning and compliance for any subsequent actions not included within this EA.	NPS would not implement this action in the same location for more than five consecutive years under this EA. If this action is not effective as a long-term solution when implemented over a 5-year period, NPS would pursue additional planning and compliance for any subsequent actions not included within this EA.
P.48 L.39	NPS internal consistency correction - Application of Piscicides (Actions C2, C3, C4; Tier 3, 4, and 2, respectively) 3.3.2.2 Impacts of the Proposed Action on Aquatic Resources	As described in Section 2.2.2.5, use of chemical controls, such as rotenone or antimycin, would be limited to use in tributary segments, and backwaters and off-channel ponds < 5 ac in size. In GCNP, piscicides could be applied (1) as a rapid response measure to address newly identified invasions of medium- to very high-risk non-native aquatic species that begin to reproduce in backwaters and off-channel ponds; (2) for long-term control of any high- to very high-risk non-native aquatic species in small backwaters or off-channel ponds, and (3) for renovation of native fish communities in tributaries where there are natural barriers that would prevent reinvasion by non-native fishes following treatment (e.g., Shinumo Creek or in Bright Angel Creek upstream of Split Rock Falls).	As described in Section 2.2.2.5, use of chemical controls, such as rotenone or antimycin, would be limited to use in backwaters and off-channel ponds < 5 ac in size, and in tributaries. In GCNP, piscicides could be applied (1) as a rapid response measure to address newly identified invasions of medium- to very high-risk non-native aquatic species that begin to reproduce in backwaters and off-channel ponds; (2) for long-term control of any high- to very high-risk non-native aquatic species in small backwaters or off-channel ponds, and (3) for renovation of native fish communities in tributaries where there are natural barriers that would prevent reinvasion by non-native fishes following treatment (e.g., Shinumo Creek or in Bright Angel Creek upstream of Split Rock Falls).
P.49 L.3	NPS internal clarification - Application of	NPS would not implement this action in the same location for more than five consecutive years. If this action is not effective as a long-term solution when implemented over a	NPS would not implement Action C3 in the same location for more than five consecutive years under this EA. If this action is not effective as a long-term solution when implemented over a 5-year period, NPS would

	Piscicides (Actions C2, C3, C4; Tier 3, 4, and 2, respectively) 3.3.2.2 Impacts of the Proposed Action on Aquatic Resources	5-year period, NPS would pursue additional planning and compliance for any subsequent actions not included within this EA.	pursue additional planning and compliance for any subsequent actions not included within this EA.
P.49 L.18	Based on USFWS consultation - Application of Piscicides (Actions C2, C3, C4; Tier 3, 4, and 2, respectively) 3.3.2.2 Impacts of the Proposed Action on Aquatic Resources	Although the intent would be to target specific non-native fish species with piscicides, both rotenone and antimycin can also be toxic to aquatic invertebrates if concentrations are high enough. Aquatic invertebrates (insects and zooplankton) have a wide range of sensitivities to rotenone and antimycin, although more is known about the response of invertebrates to rotenone than antimycin. Factors likely to affect the magnitude of impacts on invertebrates in treated areas include the concentration and duration of the piscicide treatment, life history characteristics and morphology of the invertebrate species, and proximity of non-exposed colonization sources of invertebrates to the treatment location (Vinson 2010).	Although the intent would be to target specific non-native fish species with piscicides, both rotenone and antimycin can also be toxic to aquatic invertebrates if concentrations are high enough. Aquatic invertebrates (insects and zooplankton) have a wide range of sensitivities to rotenone and antimycin, although more is known about the response of invertebrates to rotenone than antimycin. Factors likely to affect the magnitude of impacts on invertebrates in treated areas include the concentration and duration of the piscicide treatment, life history characteristics and morphology of the invertebrate species, and proximity of non-exposed colonization sources of invertebrates to the treatment location (Vinson 2010). Treatments would likely be lethal to benthic invertebrates in treated areas, but these effects would be spatially and temporally limited, within the relatively small treatment areas of < 0.5 ac backwaters (Action C1), <5 ac backwaters (Actions C2, and C3), or tributary segments (C4 only), for time periods of several months up to a year (Vinson 2010), which should be biologically negligible at the scale of invertebrate communities within the project area. Also see Section 3.4.2.2 for a discussion of effects on amphibians.
P.49 L.42	SNWA/Nevada comments on chemical treatment limitations - 3.3.2.2 Impacts of the Proposed Action on Aquatic Resources - Application of Herbicides (Action C5; Tier 1)	It is anticipated that the small-scale application of approved herbicides would not alter substrate conditions in targeted habitats. Applied herbicides and chemical breakdown products would persist and affect water quality within treated habitats for some time following application, dependent on chemical-specific characteristics and ambient water conditions (e.g., temperature, oxidation-reduction potential, and pH) (Section 3.2.2). Adherence to approved application guidelines and requirements would minimize impacts on aquatic organisms due to water quality changes. NPS would not implement this action in the same location for more than five consecutive years. If this action is not effective as a long-term solution when implemented over a 5-year period, NPS would pursue additional planning and compliance for any subsequent actions not included within this EA.	It is anticipated that the small-scale application of approved herbicides would not alter substrate conditions in targeted habitats. Applied herbicides and chemical breakdown products would persist and affect water quality within treated habitats for some time following application, dependent on chemical-specific characteristics and ambient water conditions (e.g., temperature, oxidation-reduction potential, and pH) (Section 3.2.2). Adherence to approved application guidelines and requirements would minimize impacts on aquatic organisms due to water quality changes.

P.50 L.8	Added cross reference to address Sierra Club comment - 3.3.2.2 Impacts of the Proposed Action on Aquatic Resources - Application of Mollusk Repellents and Non-Toxic Antifouling Paints (Action C6; Tier 1)	It is anticipated that the proposed applications would not result in direct physical impacts to aquatic habitat within the project area. The intent is to utilize non-toxic compounds and no degradation of water quality or toxicity to non-target organisms in aquatic habitats would be expected.	It is anticipated that the proposed applications would not result in direct physical impacts to aquatic habitat within the project area. The intent is to utilize non-toxic compounds and no degradation of water quality (see Section 3.2.2.2) or toxicity to non-target organisms in aquatic habitats would be expected.
P.50 L.26	UCRC comments on cumulative statements - 3.3.2.2 Impacts of the Proposed Action on Aquatic Resources - Cumulative Impacts of the Proposed Action on Aquatic Resources	Significant, mostly adverse cumulative impacts on aquatic resources in the project area primarily result from changes in seasonal and annual flow patterns. Past, present, and reasonably foreseeable future actions and trends have or are expected to produce increased water demand (resulting from population growth and development); decreased water supply (resulting from drought and increased water temperature attributed to climate change); and other foreseeable actions (DOI 2016a; see Appendix B, Table B-1).	Significant, mostly adverse cumulative impacts on aquatic resources in the project area primarily result from the presence of the dam, however there have been successive changes in seasonal and annual flow patterns since construction that have partially moderated those impacts (DOI 2016a). Past, present, and reasonably foreseeable future actions and trends have or are expected to produce increased water demand (resulting from population growth and development) and decreased water supply (resulting from drought and increased water temperature attributed to climate change) (DOI 2016a; see Appendix B, Table B-1).
P.52 L.13	Zuni sonic concussive concerns - 3.4.1.2 Terrestrial and Wetland Vegetation—Environmental Consequences - Impacts of the Proposed Action on Terrestrial and Wetland Vegetation	Several actions included in the Proposed Action, such as incentivized harvest (Action H1), mechanical removal (Action M2), mechanical disruption of habitats (Action M1), sonic concussion (Action M3), and temperature control (Action P5) could result in minimal localized impacts from trampling of shoreline vegetation by those implementing the actions. Affected vegetation would be expected to quickly recover to pre-disturbance conditions. The placement of weirs and barriers (Actions P2, P3) could result in a localized loss of vegetation where placement requires soil disturbance. YY male introduction (Action B1), chemical controls using piscicides (Actions C2, C3, C4), and mollusk repellants (C5) would have no impact on terrestrial vegetation.	Several actions included in the Proposed Action, such as incentivized harvest (Action H1), mechanical removal (Action M2), mechanical disruption of habitats (Action M1), acoustic fish deterrent and guidance devices (Action M3), and temperature control (Action P5) could result in minimal localized impacts from trampling of shoreline vegetation by those implementing the actions. Affected vegetation would be expected to quickly recover to pre-disturbance conditions. The placement of weirs and barriers (Actions P2, P3) could result in a localized loss of vegetation where placement requires soil disturbance. YY male introduction (Action B1), chemical controls using piscicides (Actions C2, C3, C4), and mollusk repellents (C5) would have no impact on terrestrial vegetation.
P.52 L.35	NPS internal clarification - 3.4.1.2 Terrestrial and Wetland Vegetation—Environmental Consequences - Impacts	Dredging to connect the Upper and Lower Sloughs (Action P4) to drain the Upper Slough and facilitate the use of a water-control structure at the outlet of the Upper Slough would result in disturbance of an area of approximately 3,400 ft2. This action includes a small channel being excavated up through the slough to facilitate completely	Dredging to connect the Upper and Lower Sloughs (Action P4) to drain the Upper Slough and facilitate the use of a water-control structure at the outlet of the Upper Slough would result in direct disturbance of an area of approximately 3,400 ft2 (0.07 acres). This action includes a small channel being excavated from the Lower Slough up through the Upper Slough to facilitate completely draining all of the water out the headgate with a

	of the Proposed Action on Terrestrial and Wetland Vegetation	draining all of the water out the headgate. Existing vegetation in the area of the water-control structure would be removed. Installation of a water-control structure would allow draining for control of both invasive animals and plants and refilling would be through natural recharge. However, some loss of riparian vegetation may result from prolonged desiccation while refilling occurs (approximately 42 days to refill the slough at 2 gal/min or 17 days at 5 gal/min depending on spring flow and evaporation at time of treatment). Permitting through the USACE under Section 404 of the Clean Water Act may be required for dredging of a channel and installation of a water-control structure. Design details and required mitigation would be determined during the permitting process.	maximum of 150 cubic yards of material dredged and then redistributed on the adjacent cobble bar. Existing vegetation in the area of the water-control structure would be removed and after construction disturbed areas would be revegetated with native species as needed. Best management practices would be used as specified in Appendix C, section C.4 to minimize impacts. Installation of a water-control structure would allow draining for control of both invasive animals and plants and refilling would be through natural recharge. However, some loss of riparian vegetation may result from prolonged desiccation while the area is drained for treatment and as refilling occurs (approximately 7 to 21 days total depending on spring flow and evaporation at time of treatment). The dominant plant species around the periphery of wetland include: Coyote willow (Salix exigua, FACW), Carex hystricina, , Juncus balticus (FACW), Juncus torreyi (FACW), Juncus ensifolius (FACW), Juncus articulatus (OBL)(along edge of Lower Slough with fluctuating water levels); Equisetum xferrissii (FACW) (a sterile hybrid species), and Euthamia occidentalis (FACW). The drying and impacts to the wetland vegetation on the fringe of the Upper Slough would be localized (less than 0.25 acres of wetland fringe vegetation impacted) and temporary (less than 21 days per draining action). Vegetation monitoring would be implemented before and after construction and before and after each periodic draining action. Wetland impacts of all the actions in the Proposed Alternative, and particularly action P4, were considered based on EO 11990 and DO 77-1, Given the limited area of impact (<0.25 acres, limited time period of impact and the resilience of the dominant species in this wetland fringe community, and best management practices listed in Appendix C, section C.4, it is expected that there would be very little impact to the natural wetland processes, functions, and values and action P4 would fall under the exemption for restoration projects in the Procedural Manual #77-1 for Wetland Protection (NPS 2016). Potential impacts to floodplains were considered as specified in EO 11988 and DO 77-2 and this action and all others in the Proposed Action were found to present no additional risk to human life, capital investment or to the natural and beneficial values of this area of floodplain. Permitting through the USACE under Section 404 of the Clean Water Act may be required for dredging of a channel and installation of a water-control structure. Design details and required mitigation would be determined during the permitting process.
P.54 L.24	SNWA comment regarding flycatcher	The southwestern willow flycatcher (federally listed as endangered) occurs throughout GCNP in riparian habitats,	The southwestern willow flycatcher (federally listed as endangered) has been documented nesting in Marble Canyon and the western Grand

	identification - 3.4.2.1 Wildlife—Affected Environment	including those dominated by invasive tamarisk. Resident birds have been documented nesting in Marble Canyon and the western Grand Canyon near Lake Mead (DOI 2016a). The breeding season of the southwestern willow flycatcher is May through August (Reclamation 2007, Sogge et al. 1997, 2010).	Canyon near Lake Mead (DOI 2016a). The breeding season of the southwestern willow flycatcher is May through August (Reclamation 2007, Sogge et al. 1997, 2010). Willow flycatchers have been observed throughout GCNP in riparian habitats, but some of the willow flycatchers reported in GCNP may not be the endangered southwestern subspecies. Only willow flycatchers found in GCNP during the breeding season or during the period between the northbound and southbound migration time period (between mid-June and mid-July) are considered to be the endangered southwestern willow flycatcher.
P.55 L.34	Zuni and NPS internal consistency corrections - 3.4.2.2 Wildlife—Environmental Consequences - Impacts of the Proposed Action on Wildlife	No impacts on the Kanab ambersnail are expected because this species occurs in two locations within Grand Canyon (Vasey's Paradise and Elves Chasm) that are primarily above the 33,000 cfs stage elevation at Vasey's Paradise and above the 45,000 cfs stage elevation at Elves Chasm (DOI 2016a) and mitigation measures will preclude the use of actions in close proximity that could affect this species (see Appendix C, Section C.4). No chemical, sonic concussive treatments, or mechanical harvesting of aquatic plants and algae would occur within 330 ft (100 m) of known locations of Kanab ambersnail.	No impacts on the Kanab ambersnail are expected because this species occurs in two locations within Grand Canyon (Vasey's Paradise and Elves Chasm) that are primarily above the 33,000 cfs stage elevation at Vasey's Paradise and above the 45,000 cfs stage elevation at Elves Chasm (DOI 2016a) and mitigation measures will preclude the use of actions in close proximity that could affect this species (see Appendix C, Section C.4). No chemical, mechanical removal, or mechanical harvesting of aquatic plants and algae would occur within 330 ft (100 m) of known locations of Kanab ambersnail.
P.56 L.1	Zuni - 3.4.2.2 Wildlife—Environmental Consequences	Some of the control actions under the Proposed Action could affect amphibians occupying habitat in and around ponds and backwaters where control actions are implemented. These options include mechanical disruption (Action M1), sonic concussion (Action M3), dewatering of off-channel ponds and backwaters (Action P1), ecosystem cycling control (Action C1), piscicide application (C2, C3, and C4) dredging to connect the Upper and Lower Sloughs (Action P4), mechanical harvest of non-native aquatic plants (Action M4), and application of herbicides (Action C5).	Some of the control actions under the Proposed Action could affect amphibians occupying habitat in and around ponds and backwaters where control actions are implemented. These options include mechanical disruption (Action M1), acoustic fish deterrent and guidance devices (Action M3), dewatering of off-channel ponds and backwaters (Action P1), ecosystem cycling control (Action C1), piscicide application (C2, C3, and C4) dredging to connect the Upper and Lower Sloughs (Action P4), mechanical harvest of non-native aquatic plants (Action M4), and application of herbicides (Action C5).
P.56 L.20	Zuni sonic concussive concerns and NPS internal consistency corrections - 3.4.2.2 Wildlife—Environmental Consequences	Special status species that may occur in or near riparian areas, and, therefore, may be present near the locations where control actions are implemented include: California condor, southwestern willow flycatcher, western yellow-billed cuckoo, Ridgway's rail (Yuma), and bald eagles. Species that breed in riparian vegetation upstream of Lake Mead include the southwestern willow flycatcher, western yellow-billed cuckoo, and Ridgway's rail (Yuma). Disturbance of these species may result from any of the control actions, particularly those with appreciable noise	Special status species that may occur in or near riparian areas, and, therefore, may be present near the locations where control actions are implemented include: California condor, southwestern willow flycatcher, western yellow-billed cuckoo, Ridgway's rail (Yuma), and bald eagles. Species that breed in riparian vegetation upstream of Lake Mead include the southwestern willow flycatcher, western yellow-billed cuckoo, and Ridgway's rail (Yuma). Disturbance of these species may result from any of the control actions, particularly those with appreciable noise generation, such as the operation of pumps, propane heaters, generators used during electrofishing, generators or pumps used when implementing acoustic

		generation, such as the operation of pumps, propane heaters, generators used during electrofishing, hydraulic pumps used during sonic concussive methods, pumps used for pressure washers for treating spawning beds, construction equipment during dredging, or additional motorized river trips.	guidance actions, pumps used for pressure washers for treating spawning beds, construction equipment during dredging, or additional motorized river trips.
P.60 L.8	NPS Internal consistency corrections - 3.5.2.1 Traditional Cultural Properties - Impacts of the No-Action Alternative on Traditional Cultural Properties -	All mechanical removal or flow actions under the No-Action Alternative would adversely affect non-native fish, which are considered a contributing element of the documented TCP for the Pueblo of Zuni and Hopi Tribe.	Mechanical removal and certain flow actions under the No-Action Alternative were determined to adversely affect non-native fish, which are considered a contributing element of the documented TCP for the Pueblo of Zuni and Hopi Tribe.
P.60 L.17	NPS Internal consistency corrections - 3.5.2.1 Traditional Cultural Properties - Impacts of the Proposed Action on Traditional Cultural Properties	The Proposed Action represents an increase in the type of actions that could occur under the No-Action Alternative, the locations in which those actions could occur, and their frequency of occurrence. All mechanical and chemical actions under the Proposed Action would adversely affect the non-native fish and other aquatic species, which are considered a contributing element of the documented TCP for the Pueblo of Zuni and Hopi Tribe. All archaeological sites are considered to be contributing elements to the TCP, and although impacts to sites would be avoided, if an unanticipated impact does occur, it could affect the associative value of the properties.	The Proposed Action represents an increase in the type of actions that could occur under the No-Action Alternative, the locations in which those actions could occur, and their frequency of occurrence. Some actions under the Proposed Action would adversely affect the non-native fish and other aquatic species, which are considered a contributing element of the documented TCP for the Pueblo of Zuni and Hopi Tribe. All archaeological sites are considered to be contributing elements to the TCP, and although impacts to sites would be avoided, if an unanticipated impact does occur, it could affect the associative value of the properties.
P.60 L.32	Zuni comments, and NPS Internal consistency corrections - 3.5.2.1 Traditional Cultural Properties - Impacts of the Proposed Action on Traditional Cultural Properties	Applications of pesticides, piscicides, or other chemicals (Actions C1 through C6), mechanical control actions (Actions M1-M4), or physical control actions (P5) could affect water quality, plants, and animals. Some Tribes have expressed a preference for letting nature take its course rather than intervening to mitigate the consequences of past actions, and many Tribes have expressed confusion regarding the conflicting management goals of maintaining a native population of fish while simultaneously supporting a recreational rainbow trout fishery in the same river (DOI 2016a). Tribal viewpoints are summarized in this section; greater detail is presented in Appendix H of this EA and in Sections 3 and 4 of the LTEMP EIS (DOI 2016a).	Applications of pesticides, piscicides, or other chemicals (Actions C1 through C6), mechanical control actions (Actions M1-M4), or physical control actions (P5) could affect water quality, plants, and animals. Some Tribes have expressed a preference for letting nature take its course rather than intervening to mitigate the consequences of past actions, and many Tribes have expressed confusion regarding the conflicting management goals of maintaining a native population of fish while simultaneously supporting a recreational rainbow trout fishery in the same river (DOI 2016a). The Hopi and Zuni prepared text to describe their perspective on lethal management actions, which was included in Runge et al. (2018). Tribal viewpoints are summarized in this section; greater detail is presented in Appendix H of this EA and in Sections 3 and 4 of the LTEMP EIS (DOI 2016a).

		The Zuni and Hopi in particular have been the most vocal Tribes regarding their concerns of lethal management actions applied to non-native fish and other aquatic species. Fish and other aquatic species are considered contributing elements to both Tribes' TCPs; consequently, lethal management actions would be considered an adverse effect on the TCP. The Hopi and Zuni prepared text to describe their perspective on lethal management actions, which was included in Runge et al. (2018). An excerpt of this text is presented in Appendix H and summarized briefly below. The Zuni have consistently expressed their objection to lethal management actions. The Zuni have familial and spiritual relationships to all aquatic life, including native and non-native fish and macroinvertebrates. The taking of life without beneficial use is contrary to their cultural values and the Zuni believe these actions could have adverse impacts on their community (Runge et al. 2018). The Hopi have similarly expressed their concerns with lethal management actions. The Hopi acknowledge and have expressed agreement with the purpose of trying to protect native species, but many believe that killing large numbers of fish without beneficial use is wrong. (See Appendix H for a more detailed description of the Hopi viewpoint). Those who support removal, state it should only be used if there is strong evidence that non-native species are a real threat to the survival of native species. Several Tribes, particularly the Hopi, Zuni, and Navajo, have expressed a preference for live removal in past agreements with Reclamation (Reclamation 2012; Runge et al. 2018). To address these concerns, NPS has adopted a tiered adaptive implementation approach that retains the use of mechanical removal and chemical controls, but only as actions of last resort, and includes beneficial use of fish with consideration of live removal if possible as the preferred approach to removal.	The Zuni and Hopi representatives, in particular, have been the most vocal Tribes regarding their concerns of lethal management actions applied to non-native fish and other aquatic species. As presented in Appendix H, the Pueblo of Zuni have explained that "all aquatic life is recognized by present day Zunis to be descendants of those Zuni children who were lost to the waters, thus creating a strong and lasting familial bond to all aquatic life and a fundamentally important stewardship responsibility. It is precisely because of this familial bond and stewardship responsibility that the Pueblo of Zuni has for the past ten (10) years communicated to the Department of the Interior objections to any management actions (e.g., mechanical removal, trout suppression flows, piscicides) that entail the taking of aquatic life." They have also stated, "The implementation of lethal fish management actions is contrary to Zuni worldview and environmental ethics. Annual ceremonial activities carried out by the Zuni are performed to ensure adequate rainfall and prosperity for all life," and "To needlessly take life causes an imbalance in the natural world and also disturbs the harmony and health of the spiritual realm and the Zuni peoples." The Zuni people have consistently expressed their objection to lethal management actions, with the exception of incentivized harvest (Action H1). They have familial and spiritual relationships to all aquatic life, including native and non-native fish and macroinvertebrates. The taking of aquatic life without beneficial use is contrary to their cultural values and they believe these actions could have adverse impacts on their community (Runge et al. 2018). In 2010, the Zuni Tribal Council passed Resolution M 70-2010-C086 which calls upon DOI to "consult in good faith with the Zuni Tribe in seeking and reaching agreement with the Zuni about measures to avoid, reduce, compensate for, or otherwise mitigate any adverse effects on tribal, cultural and spiritual values in the Grand Canyon that are the result of mechanical removal actions." The NPS has endeavored to work closely with the Pueblo of Zuni on these concerns related to the taking of life throughout this EA process. The Hopi people have similarly expressed their concerns with lethal management actions. The Hopi acknowledge and have expressed agreement with the purpose of trying to protect native species, but many believe that killing large numbers of fish without beneficial use is wrong. (See Appendix H for a more detailed description of the Hopi viewpoint). Those who support removal state it should only be used if there is strong

		Several Tribes, particularly the Zuni, Hopi, and the Southern Paiute Consortium have expressed concern about the introduction of YY-male trout or other species (Action B1) as a method of controlling target populations, because these fish are artificially modified before release. NPS considers this action experimental and is separate from the tiered approach. It would not be considered for implementation until brood stock became available (5 to 8 years in the future) and more research has been conducted on its efficacy. Prior to implementation, NPS would review new modeling and field studies to determine if additional compliance was needed; consult with AGFD, GCMRC, FWS, Reclamation, and Tribes; and discuss this option with stakeholders through the AMWG and TWG to seek consensus. NPS retains decision-making authority as the action agency.	evidence that non-native species are a real threat to the survival of native species. Several Tribes, particularly the Hopi, Zuni, and Navajo, have expressed a preference for live removal in past agreements with Reclamation (Reclamation 2012b; Runge et al. 2018). Several Tribes, particularly the Zuni, Hopi, and the Southern Paiute Consortium have expressed concern about the introduction of YY-male trout or other species (Action B1) as a method of controlling target populations, because these fish are artificially modified before release. NPS considers this action experimental and is separate from the tiered approach. It would not be considered for implementation until brood stock became available (5 to 8 years in the future) and more research has been conducted on its efficacy. Prior to implementation, NPS would consult with Tribes and others; and discuss this option with stakeholders through the AMWG and TWG.
P.62 L.1	Zuni comments and NPS Internal consistency corrections - 3.5.2.1 Traditional Cultural Properties - Impacts of the Proposed Action on Traditional Cultural Properties	In order to address the impacts on the Colorado River Ecosystem TCP, NPS would continue to regularly inform Tribes of intended management actions and consult on the appropriate measures for mitigation based on the management action. Examples of potential mitigations include live transport and relocation of green sunfish or beneficial use of removed non-native fish as described above. Beneficial use involves collecting fish during management actions and transporting them to Tribes for either human consumption or for use in aviaries or similar uses. Although beneficial use has been used in the past (Reclamation 2011), it should be noted that what is considered beneficial use may not be the same for all Tribes and is considered only a partial mitigation by most Tribes. What a Tribe considers beneficial use may also change over time as communities become more aware of specific management actions.	These concerns regarding the effects on fish and other aquatic species that are considered contributing elements to both Tribes' TCPs, suggest that some of the lethal management actions in the Proposed Action would be considered an adverse effect on the TCP by the Tribes if they are used. To address these concerns, NPS has adopted a tiered adaptive implementation approach that tries to use less management intensive tools in the first tiers and retains the use of mechanical removal and chemical controls, only as actions of last resort. These actions include beneficial use of fish and consideration of live removal of green sunfish where possible as the preferred approach to removal. NPS also removed one action, sonic concussive devices, which were considered particularly offensive to the Pueblo of Zuni. NPS intends to avoid the actions that would be objectionable to Tribes to the extent possible, and to work with Tribes under a Programmatic Agreement (PA) to address potential effects of some of the actions as implementation occurs over the life of this plan. The PA will define the process by which NPS would continue to regularly inform Tribes of intended management actions or consult on the appropriate measures for mitigation based on the management action. Examples of potential mitigations include live transport and relocation of green sunfish or beneficial use of removed non-native fish as described above. Beneficial use involves collecting fish during management actions and transporting them to Tribes for either human consumption or for use in aviaries or similar uses. Although beneficial use has been used in the past (Reclamation 2011), it should be noted that what is considered beneficial use may not be the same for all Tribes and is considered only a

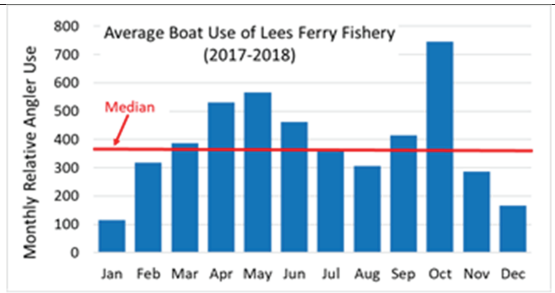
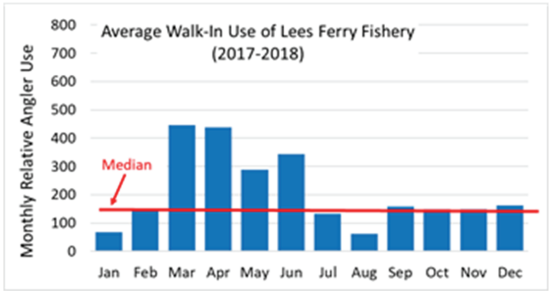
			partial mitigation by most Tribes. What a Tribe considers beneficial use may also change over time as communities become more aware of specific management actions.
P.63 L.29	Hopi comment to remove repeated text - 3.5.2.5 Cumulative Impacts on Tribal and Cultural Resources – to eliminate redundant text	Past and present actions in the project area have ongoing adverse impacts on many Tribal communities (DOI 2016a). Reclamation has entered into a Programmatic Agreement to address any potential effects to cultural and historic properties under LTEMP. The LTEMP includes mechanical removal of trout and trout management flows, both of which will have an adverse impact on the TCP because fish are a contributing element. Actions and basin-wide trends affecting aquatic life, vegetation, and wildlife (as described above) would also affect resources of value to Tribes. The LTEMP includes vegetation treatments that improve vegetation conditions and could lead to a more natural riparian ecosystem contributing to the overall better health of the Canyons, which would be considered a benefit.	Past and present actions in the project area have ongoing adverse impacts on many Tribal communities (DOI 2016a). Reclamation has entered into a Programmatic Agreement to address any potential effects to cultural and historic properties under LTEMP.
P.63 L.43	NPS Internal consistency corrections - 3.5.2.5 Cumulative Impacts on Tribal and Cultural Resources	The Proposed Action's contribution to cumulative impacts on cultural resources would increase impacts on the Canyons as a TCP if lower tier actions are not successful and lethal methods of control cannot be conducted with beneficial use. Tribes believe the undertaking has the potential to have an adverse effect on both ethnographic and identified traditional cultural properties of importance to American Indian Tribes. This includes impacts from lethal aquatic species management and monitoring actions and the experimental introduction of YY-male non-native fish. Chemical control actions, if used, could also adversely affect water quality and overall health of the Canyons. The Proposed Action is not expected to contribute to cumulative impacts on archaeological sites, historic districts, and cultural landscapes.	The Proposed Action's contribution to cumulative impacts on cultural resources would increase impacts on the Canyons as a TCP if lower tier actions are not successful and lethal methods of control cannot be conducted with beneficial use. Some Tribes believe the undertaking has the potential to have an adverse effect on both ethnographic and identified traditional cultural properties of importance to American Indian Tribes. This includes impacts from lethal aquatic species management and monitoring actions and the experimental introduction of YY-male non-native fish. Chemical control actions, if used, could also adversely affect water quality for relatively short periods (up to several weeks) and in relatively small treated areas (< 5 ac for backwaters and off-channel ponds and some tributaries). The Proposed Action is not expected to contribute to cumulative impacts on archaeological sites, historic districts, and cultural landscapes.
P.64 L.15	Hualapai comment - 3.5.3 Indian Trust Assets and Trust Responsibility	The project area is bounded on the east by the Navajo Indian Reservation and on the south by the Hualapai Indian Reservation. The NPS has ongoing consultation with these Tribes regarding potential effects of NPS management action on their lands, resources, trust assets, and reserved rights. Analysis of effects on resources show that the Proposed Action is not likely to affect Indian lands, minerals, or water rights.	The project area is bounded partially on the east by the Navajo Indian Reservation and partially on the south by the Hualapai Indian Reservation. The NPS has ongoing consultation with these Tribes regarding potential effects of NPS management action on their lands, resources, trust assets, and reserved rights. Analysis of effects on resources show that the Proposed Action is not likely to affect Indian lands, minerals, or water rights.

P.65 L.10	Anglers – 3.6.1.1 Glen Canyon National Recreation Area	The condition of the rainbow trout fishery has varied considerably over time in response to management actions, stocking, dam release patterns, changing reservoir conditions, and food availability. Approximately 10,900 anglers used the fishery in 2014, of which 6,700 were boat anglers who accessed the boat-fishing section upriver of Lees Ferry, and 4,200 were walk-in shore anglers, mainly accessing the 1.2-mi walk-in section at Lees Ferry downstream of the launch facility. Fishing occurs year-round, with peak fishing occurring in April and May, but remaining high through October. Five commercial guided fish operations served about 50% of boat-based fishing in 2011, and served about 3,000 clients in each of the preceding 4 years (DOI 2016a).	The condition of the rainbow trout fishery has varied considerably over time in response to management actions, stocking, dam release patterns, changing reservoir conditions, and food availability. Approximately 10,900 anglers used the fishery in 2014, of which 6,700 were boat anglers who accessed the boat-fishing section upriver of Lees Ferry, and 4,200 were walk-in shore anglers, mainly accessing the 1.2-mi walk-in section at Lees Ferry downstream of the launch facility. Fishing occurs year-round, with peak fishing occurring typically in April and May, but remaining high through October (see figure 3-1). Five commercial guided fish operations served about 50% of boat-based fishing in 2011, and served about 3,000 clients in each of the preceding 4 years (DOI 2016a).
P.67 L.23	Anglers - 3.6.2.2 Impacts of the Proposed Action on Recreation, Visitor Use, and Experience	Mechanical removal, when targeting brown trout in the Glen Canyon reach, could have negative impacts on catchability of rainbow trout for a few days following the mechanical removal. However, this would primarily occur between November 1 and February 28, when fishing use is low, so would effect a smaller number of anglers. Increases in boat and helicopter traffic would have a small impact on visitor experience, as they represent a small addition to the helicopter and boat traffic that is already occurring.	Mechanical removal, when targeting brown trout in the Glen Canyon reach, could have negative impacts on catchability of rainbow trout for a few days following the mechanical removal. However, this would primarily occur between November 1 and February 28, when fishing use is typically lower (see Figure 3-1), so would effect a smaller number of anglers. Increases in boat and helicopter traffic would have a small impact on visitor experience, as they represent a small addition to the helicopter and boat traffic that is already occurring.
P.67 L.23	Based on USFWS consultation - 3.6.2.2 Impacts of the Proposed Action on Recreation, Visitor Use, and Experience	Equipment used to install control structures, dig trenches, or power pumps and other equipment would generate noise, both continuous and intermittent. Installation and control actions would typically occur for less than a week in any one area. Activities would generate noises of various character, from loud, percussive noise, to constant moderate noise, for example from electrical generators and pumps. In addition, odors from fuels, exhaust, and disturbed sediments would emanate from some work areas. In GCNRA, these would not occur in wilderness areas and therefore would not affect wilderness character. Equipment operation should not interfere with recreational fishing, boating, or hiking, but may have a slight negative affect on waterfowl hunting in GCNRA. Action M1 (spawning bed treatment) would not occur in wilderness areas, but the sediment and gravel	Equipment used to install control structures, dig trenches, or power pumps and other equipment would generate noise, both continuous and intermittent. Installation and control actions would typically occur for less than a week in any one area. Activities would generate noises of various character, from potentially loud, percussive noise, to constant moderate noise, for example from electrical generators and pumps. In addition, odors from fuels, exhaust, and disturbed sediments would emanate from some work areas. In GCNRA, these would not occur in wilderness areas and therefore would not affect wilderness character. Equipment operation should not interfere with recreational fishing, boating, or hiking, but may have a slight negative affect on waterfowl hunting in GCNRA. Action M1 (spawning bed treatment) would occur mainly in the mainstem, and if it occurred in the tributaries, it would only be with hand equipment, not pressurized sprayers that would generate noise in proposed wilderness areas. When used on the mainstem, it could generate noise from the equipment used or slight odors from fumes and disturbed sediments.

		displacement would generate noise from the equipment used and odors from fumes and disturbed sediments.	
P.69 L.3	GCMRC corrections - 3.7.1.2 Socioeconomics—Environmental Consequences, Impacts of the No-Action Alternative on Socioeconomics	The presence and operation of Glen Canyon Dam and Lake Powell have provided benefits to recreational socioeconomics associated with angling and boating, mostly in GCNRA. However, projected future changes in reservoir levels and river flow due to increased water demand, decreased water supply, and drought attributed to climate change are the greatest contributors to adverse cumulative impacts on the recreational use values associated with fishing, day rafting, and whitewater boating (DOI 2016a; see Appendix B, Table B-1). The annual release volume from Glen Canyon Dam, as determined by the 2007 Interim Guidelines, also affects recreation economics. The impacts of the No-Action Alternative described in the preceding paragraph represent a negligible contribution to the cumulative impact of past, present, and reasonably foreseeable future actions on socioeconomics.	The presence and operation of Glen Canyon Dam and Lake Powell have provided socioeconomic benefits to recreation associated with angling and boating, mostly in GCNRA. However, projected future changes in reservoir levels and river flow due to increased water demand, decreased water supply, and drought attributed to climate change are the greatest contributors to adverse cumulative impacts on the recreational use values associated with fishing, day rafting, and whitewater boating (DOI 2016a; see Appendix B, Table B-1). The annual release volume from Glen Canyon Dam, as determined by the 2007 Interim Guidelines, also affects the economic value of recreation. The impacts of the No-Action Alternative described in the preceding paragraph represent a negligible contribution to the cumulative impact of past, present, and reasonably foreseeable future actions on socioeconomic conditions.
P.69 L.20	Anglers, AGFD comments, GCMRC and NPS Internal consistency corrections - 3.7.1.2 Socioeconomics—Environmental Consequences, Impacts of the Proposed Action on Socioeconomics	Because the control actions under the Proposed Action are limited in scope and scale, target isolated areas including backwaters and off-channel ponds, and are temporary and short-duration in nature, they would have only negligible effects on factors related to the local and regional economy. Actions would have negligible adverse effects on tourism, fishing, hiking, river trips, or on demands on park facilities. In addition, the actions would not affect related socioeconomic resources, such as housing, lodging, or schools. The control action with the highest likelihood to benefit anglers, the angling guides, and the local community is incentivized harvest (Action H1) to remove brown trout and possibly other species. Rewards for target fish harvested by anglers would be paid out, guided trips would be reserved for Tribal participants and may involve overnight stays in the local area, and more visitor use and traffic may occur during the off-season periods. An action of concern to the public expressed during public scoping is the potential effect of mechanical removal of brown trout in the Glen Canyon reach on the rainbow trout fishery and the local economy. There are several factors that should reduce the potential for adverse impact of this action on the rainbow trout fishery.	Because most of the control actions under the Proposed Action are limited in scope and scale, target isolated areas including backwaters and off-channel ponds, and are temporary and short-duration in nature, they would have only negligible effects on factors related to the local and regional economy. Actions, except what is noted below, would have negligible adverse effects on tourism, fishing, hiking, river trips, or on demands on park facilities. In addition, the actions would not affect related socioeconomic resources, such as housing, lodging, or schools. The control action with the highest likelihood to benefit anglers, the angling guides, and the local community is incentivized harvest (Action H1) to remove brown trout and possibly other species. This action could be slightly beneficial by increasing visitation and spending during the regular season as well as potentially extending the off-season as NPS would encourage harvest of brown trout in the Glen Canyon reach between November and February, when angling is typically lower (see Figure 3-1 below). Rewards for target fish harvested by anglers would be paid out which could contribute to spending, NPS would be paying for guided trips for Tribal participants and those trips as well as individuals wanting to capitalize on brown trout rewards during the November-February period may increase overnight stays in the local area, and more

		Mechanical removal of brown trout in the Glen Canyon reach is a Tier 3 activity, and, thus, other lower tier actions would be implemented before this action. Mechanical removal would occur during the brown trout spawning period (between November 1 and February 28), which is outside of the peak angling period (April and May). The numbers of trips associated with this effort would likely not exceed 8 multi-day boat trips per year for the entire Glen Canyon reach and the amount of time or mechanical removal effort (e.g., electrofishing) at any specific location during a sampling pass would be only a portion of each 24-hour period and would primarily occur at night. Thus, brown trout control in the Glen Canyon reach is likely to occur relatively infrequently and result in only negligible disruption of angling with little adverse economic impact, and potentially a benefit if the action successfully improves the rainbow trout fishery as intended. It should be noted that even if mechanical removal activities do not alter rainbow trout population levels or catchability, as described in Section 3.3.2.2, there could be negative impacts to the local fishery economy if anglers perceive that fishing opportunities or catch would be affected. In addition, it is expected that incentivized harvest would continue during the mechanical harvest treatments.	visitor use and traffic to local business may occur during this off-season period. An action of concern to the public expressed during public scoping is the potential effects of spawning bed treatment or mechanical removal of brown trout in the Glen Canyon reach on the rainbow trout fishery and the local economy. There are several factors that should reduce the potential for adverse impact of these actions on the rainbow trout fishery. For Action M1, mechanical disruption of spawning beds, would be limited spatially and temporally such that it should have little impact on rainbow trout reproduction. This action would be conducted primarily between November 1 and February 28 when targeting brown trout, which is outside of peak rainbow trout spawning, which is typically late February to early March (Avery et al. 2015). The known spawning bed areas for brown trout are at this time spatially limited within the Glen Canyon reach to 4-mile bar area (approximately 4 river miles upstream of Lees Ferry) (Korman et al. 2016). It should be noted that brown trout spawning could be occurring elsewhere, but has not been observed. However, to mitigate concerns on this issue, NPS would likely conduct a smaller pilot of this experiment, planned in coordination and consultation with GCMRC and AGFD, and would work with others to collect monitoring and mapping information on the spawning areas in Glen Canyon reach prior to any widespread treatment approach. The effects to the recreational rainbow trout fishery from this action are anticipated to be negligible because effects to rainbow trout spawning are expected to be negligible and these actions would occur in the angling off-season and be limited in terms of their duration and spatial extent. In terms of the potential effects of mechanical removal of brown trout in the Glen Canyon reach (Action M2) to the economics of the rainbow trout recreational fishery, this action is a Tier 3 activity, and, thus, other lower tier actions would be implemented before this action. Mechanical removal would occur during the brown trout spawning period (primarily between November 1 and February 28), which is outside of the typical peak angling period (see Figure 3-1). The numbers of trips associated with this effort would likely not exceed 8 multi-day boat trips per year for the entire Glen Canyon reach and the amount of time or mechanical removal effort (e.g., electrofishing) at any specific location during a sampling pass would be only a portion of each 24-hour period and would primarily occur at

			night. Thus, brown trout control in the Glen Canyon reach is likely to occur relatively infrequently and result in only negligible disruption of angling with little adverse economic impact, and potentially a benefit if the action successfully improves the rainbow trout fishery as intended. In terms of catchability, the mechanical removal would occur when angling is lower in the winter and, although the feeding activity of fish subjected to the electrical field may be temporarily reduced, the impact would be limited in time and space, as only a short portion of the reach can be electrofished each night, so the effect to angler catch would only occur in the immediate area of treatment on the next day. It should be noted that even if mechanical removal activities do not alter rainbow trout population levels or catchability, as described in Section 3.3.2.2, there could be negative impacts to the local fishery economy if anglers perceive that fishing opportunities or catch would be affected. To mitigate this possibility, NPS will produce and distribute educational information about Actions M1 and M2 in cooperation with AGFD, Trout Unlimited, and other local fishing guide partners to try to dispel misinformation about effects to rainbow trout.

			  FIGURE 3-1. Monthly Angler Use Statistics for Lees Ferry Fishery showing that typically November 1-Feb 28 is a non-peak usage period. Graph shows average of 2017 and 2018 use. It should be noted that December 2018 showed slightly higher usage than median. Source: Boyer and Rogowski. i*n press*. .
P.70 L.1	Anglers, AGFD, GCMRC, NPS internal consistency correction - 3.7.1.2 Socioeconomics—Environmental Consequences, Impacts of the Proposed Action on Socioeconomics	Although not expected, there is the potential for the collective or repeated use of some or all of the potential actions of the Proposed Action to harm the Lees Ferry rainbow trout fishery or result in a negative public perception of the fishery. If this occurred, the actions could have adverse impacts on the local economy that relies on the fishery. Regular monitoring, triggers, and off-ramps are expected to detect any such effect and allow for responsive action to prevent adverse impacts. Mitigation actions, implemented in coordination with AGFD, would also be	Although not expected, there is the potential for the collective or repeated use of some or all of the potential actions of the Proposed Action to result in a negative public perception of the Lees Ferry recreational rainbow trout fishery. If this occurred, the actions could have adverse impacts on the local economy that relies on the fishery. NPS will work with partners to disseminate accurate information to avoid this perception issue. To avoid the potential for any real but unexpected negative effects to the trout fishery, regular monitoring, triggers, and off-ramps will be used and are expected to detect any negative effects and allow for responsive action to prevent any large adverse impacts. Mitigation actions, implemented in

		applied as needed to maintain a high-quality fishery. NPS would work with AGFD to develop long-term approvals to mitigate any such effects on the fishery and local economy through stocking the fishery as needed. The presence and operation of Glen Canyon Dam and Lake Powell have provided benefits to recreational socioeconomics associated with angling and boating, mostly in GCNRA. However, projected future changes in reservoir levels and river flow due to increased water demand, decreased water supply, and drought attributed to climate change are the greatest contributors to adverse cumulative impacts on the recreational use values associated with fishing, day rafting, and whitewater boating (DOI 2016a; see Appendix B, Table B-1). The annual release volume from Glen Canyon Dam, as determined by the 2007 Interim Guidelines, also affects recreation economics. Adverse impacts under the Proposed Action on the Lees Ferry trout fishery (see Section 3.3) and subsequent impacts on recreational economics are expected to be limited and outweighed by the beneficial effects on recreational economics of non-native aquatic species control. Interaction and accumulation of adverse impacts on socioeconomics from multiple control actions under the Proposed Action would be limited because (1) most individual actions and their effects would persist for less than a week, (2) most actions would occur in small (< 5 ac) habitats that are isolated from the main channel and each other, and (3) tiered implementation of actions would reduce the potential for them to occur simultaneously at specific locations. Because of limitations on adverse effects and net benefits of the Proposed Action, an overall reduction in cumulative impacts on socioeconomics is expected.	coordination with AGFD, would also be applied as needed to maintain a high-quality fishery as allowed under past compliance in the CFMP. NPS intends to continue to work with AGFD on long-term planning, after the completion of their stocking pilot project, which would evaluate actions that could mitigate any future negative effects on the rainbow trout fishery through actions such as stocking the fishery if needed. In terms of cumulative effects, the presence and operation of Glen Canyon Dam and Lake Powell have provided socioeconomic benefits to recreation associated with angling and boating, mostly in GCNRA. However, projected future changes in reservoir levels and river flow due to increased water demand, decreased water supply, and drought attributed to climate change are the greatest contributors to adverse cumulative impacts on the recreational use values associated with fishing, day rafting, and whitewater boating (DOI 2016a; see Appendix B, Table B-1). The annual release volume from Glen Canyon Dam, as determined by the 2007 Interim Guidelines, also affects the economic value of recreation. Adverse impacts under the Proposed Action on the Lees Ferry trout fishery (see Section 3.3) and subsequent impacts on the economic value of recreation are expected to be limited and outweighed by the economic benefits of recreation from non-native aquatic species control. Interaction and accumulation of adverse impacts on socioeconomic conditions from multiple control actions under the Proposed Action would be limited because (1) most individual actions and their effects would persist for less than a week, (2) most actions would occur in small (< 5 ac) habitats that are isolated from the main channel and each other, and (3) tiered implementation of actions would reduce the potential for them to occur simultaneously at specific locations. Because of limitations on adverse effects and net benefits of the Proposed Action, an overall reduction in cumulative impacts on socioeconomic conditions is expected.
P.71 L.3	NPS Internal consistency corrections - 3.7.2.2 Impacts of the Proposed Action on Environmental Justice	Environmental justice impacts would result from Tribal objections to taking of life of fish and impacts on water quality, if lower tier control actions are not successful (see Section 3.5.2.1 and Appendix B, Table B-1). Live removal and relocation, or beneficial use of fish may reduce environmental justice impacts. Cumulative impacts of past, present, and reasonably foreseeable future actions, and the	Environmental justice impacts may result from some management actions, if used, leading to Tribal objections to taking of aquatic life of fish, if lower tier control actions are not successful (see Section 3.5.2.1 and Appendix B, Table B-1). Live removal and relocation, or beneficial use of fish may reduce environmental justice impacts. Cumulative impacts of past, present, and reasonably foreseeable future actions, and the incremental contributions of the Proposed Action on cumulative impacts

		incremental contributions of the Proposed Action on cumulative impacts on Tribal resources (and, therefore, environmental justice) are presented in Section 3.5.2.5.	on Tribal resources (and, therefore, environmental justice) are presented in Section 3.5.2.5.
P A-1	Zuni comments and NPS Internal consistency corrections - TABLE A-1 No-Action Alternative, Row: Suite of Non-Flow and Flow Actions, Column: Tribal and Cultural Resources	Adverse impact to the TCP for Pueblo of Zuni and Hopi Tribe, and potentially other associated Tribes, resulting from taking of life of removed fish. An impact to one part of the TCP (fish as a contributing element) may be seen as an impact to the whole TCP. Impacts would be reduced in proportion to the degree to which beneficial use of removed fish could be achieved.	Adverse impact to the TCP for Pueblo of Zuni and Hopi Tribe, and potentially other associated Tribes, resulting from taking of aquatic life. An impact to one part of the TCP (fish as a contributing element) may be seen as an impact to the whole TCP. Impacts would be reduced in proportion to the degree to which beneficial use of removed fish could be achieved.
P A-1	Zuni comments and NPS Internal consistency corrections - TABLE A-1 Proposed Action, Row: Multiple Actions, Column: Socioeconomics and Environmental Justice	Environmental justice impacts would result from Tribal objections to taking of life of removed fish. Impacts may be reduced in proportion to the degree to which beneficial use of removed fish could be achieved.	Environmental justice impacts would result from Tribal objections to taking of aquatic life of removed fish. Impacts may be reduced in proportion to the degree to which beneficial use of removed fish could be achieved.
P A-2	Zuni comments and NPS Internal consistency corrections - TABLE A-1 No-Action Alternative, Row: Suite of Non-Flow and Flow Actions, Column: Tribal and Cultural Resources	No impacts on archaeological sites. Some impacts on TCPs resulting from taking of life and effects on water quality. Some impacts would be reduced by implementing beneficial use of removed fish.	No impacts on archaeological sites. Some impacts on TCPs resulting from taking of aquatic life and effects on water quality. Some impacts would be reduced by implementing beneficial use of removed fish.
P A-2	Zuni comments and NPS Internal consistency corrections - TABLE A-1 Proposed Action, Row: Multiple Actions, Column: Socioeconomics and Environmental Justice	Environmental justice impacts could result from impacts related to the taking of life and short-term effects on water quality. Some impacts would be reduced by implementing beneficial use of removed fish.	Environmental justice impacts could result from impacts related to the taking of aquatic life and short-term effects on water quality. Some impacts would be reduced by implementing beneficial use of removed fish.

P.A-3	Zuni comments and NPS Internal consistency corrections - TABLE A-1 Proposed Action, Row: Dewatering P1, Column: Tribal and Cultural Resources	No impact to archaeological sites. Prior to action, affected and adjacent areas would be evaluated for cultural resources, and any resources present would be avoided. Adverse impact to contributing element of TCP for Pueblo of Zuni and Hopi Tribe, and potentially other associated Tribes, resulting from taking of life of removed fish. Live removal and relocation or beneficial use of fish prior to dewatering may reduce impact.	No impact to archaeological sites. Prior to action, affected and adjacent areas would be evaluated for cultural resources, and any resources present would be avoided. Potential for the Pueblo of Zuni, Hopi Tribe, and other associated Tribes to perceive an adverse impact on a contributing element of TCPs resulting from taking of aquatic life of removed fish. Live removal and relocation or beneficial use of fish prior to dewatering may reduce impact.
P.A-4	Zuni, NPS Internal - TABLE A-1 Proposed Action, Row: Dredging P4 Column: Tribal and Cultural Resources	Potential adverse impact to contributing element of TCP for Pueblo of Zuni and Hopi Tribe, and potentially other associated Tribes, resulting from dredging-disturbed spring outflow in the Upper Slough. Adverse and potential loss of life of fish and other aquatic organisms..	Potential for the Pueblo of Zuni, Hopi Tribe, and other associated Tribes to perceive an adverse impact on a contributing element of TCPs resulting from dredging the spring outflow in the Upper Slough. Adverse and potential loss of life of fish and other aquatic organisms.
P.A-5	Zuni, NPS Internal - TABLE A-1 Proposed Action, Row: Produce Small Scale Temperature Changes P5 Column: Tribal and Cultural Resources	Adverse impact to contributing element of TCP for Pueblo of Zuni and Hopi Tribe, and potentially other associated Tribes, if raising water temperature resulted in the taking of life of coldwater fish or other aquatic organisms. Beneficial use of fish prior to use of temperature experiment placement may reduce impact.	Potential for the Pueblo of Zuni, Hopi Tribe, and other associated Tribes to perceive an adverse impact on a contributing element of TCPs if raising water temperature resulted in the taking of aquatic life. Beneficial use of fish prior to use of temperature experiment placement may reduce impact.
P.A-5	Zuni, NPS Internal - TABLE A-1 Proposed Action, Row: Produce Small Scale Temperature Changes P5 Column: Socioeconomics and Environmental Justice	Environmental justice impacts would result from Tribal objections to taking of life if coldwater fish or other aquatic organisms were killed as a result of the action.	Environmental justice impacts would result from Tribal objections to taking of aquatic life if coldwater fish or other aquatic organisms were killed as a result of the action.
P.A-5	Zuni, NPS Internal - TABLE A-1 Proposed Action, Row: Mechanical disruption of early life stage habitats M1 - Column: Tribal and Cultural Resources	Adverse impact to contributing element of TCP for Pueblo of Zuni and Hopi Tribe, and potentially other associated Tribes, resulting from taking of life of early life stages of fish.	Potential for the Pueblo of Zuni, Hopi Tribe, and other associated Tribes to perceive an adverse impact on a contributing element of TCPs resulting from taking of aquatic life of early life stages of fish.
P.A-6	Zuni - TABLE A-1. Row: Use of sonic concussive devices,	Use of sonic concussion devices Tier:4 Aquatic Resources: Beneficial effects on populations of native species due to reduction in competition and predation;	Use of acoustic fish deterrent and guidance devices Tier:1 Aquatic Resources: Beneficial effects on populations of native species through non-native species breeding reduction and therefore reduction in

	Column: Control Actions	and reduction in abundance of targeted non-native species. Adverse impacts on non-target native species within treated areas. Tribal and Cultural Resources: No impact to archaeological sites. Prior to action, areas to be used for staging of equipment would be evaluated for cultural resources, and any resources present would be avoided. Sufficient setback from Spencer Steamboat would be ensured to avoid impact on that site. Adverse impact to contributing element of TCP for Pueblo of Zuni and Hopi Tribe, and potentially other associated Tribes, resulting from loss of life of affected fish. Impacts would be reduced in proportion to the degree to which live removal and relocation or beneficial use of removed fish could be achieved prior to action Recreation, Visitor Use, and Experience: Adverse impacts on visitor experience and recreation during sonic concussion treatments. If successful, action would help prevent degradation of the fishery and provide benefits to recreation. Socioeconomics and Environmental Justice: Little potential for adverse economic impact. If successful, action would help prevent degradation of the fishery and provide economic benefits. Environmental justice impacts would result from Tribal objections to taking of life of affected fish. Impacts would be reduced in proportion to the degree to which live removal and relocation or beneficial use of removed fish could be achieved. Human Health and Safety: Physical risk to workers performing sonic concussive treatments would be managed through implementation of NPS's Occupational Safety and Health Program.	competition and predation; and reduction in abundance of targeted non-native species. Tribal and Cultural Resources: No impact to archaeological sites. Prior to action, areas to be used for staging of equipment would be evaluated for cultural resources, and any resources present would be avoided. Sufficient setback from Spencer Steamboat would be ensured to avoid impact on that site. Non-lethal acoustic fish deterrent and guidance systems would not adversely affect Tribal values. Recreation, Visitor Use, and Experience: Adverse impacts on visitor experience and recreation during acoustic fish deterrent and guidance treatments resulting from generators used to power the devices. If successful, action would help prevent degradation of the fishery and provide benefits to recreation. Socioeconomics and Environmental Justice: Little potential for adverse economic impact. If successful, action would help prevent degradation of the fishery and provide economic benefits. Human Health and Safety: Negligible physical risk to workers installing devices. Risks would be managed through implementation of NPS's Occupational Safety and Health Program.
P.A-7	Zuni, NPS Internal - TABLE A-1 Proposed Action, Row: Mechanical harvesting of non-	Adverse impact to contributing element of TCP for Pueblo of Zuni and Hopi Tribe, and potentially other associated Tribes, resulting from loss of life of incidentally removed fish that may be enmeshed in the plants when removed.	Potential for the Pueblo of Zuni, Hopi Tribe, and other associated Tribes to perceive an adverse impact to a contributing element of TCPs resulting from loss of life of incidentally removed fish that may be enmeshed in the plants when removed.

	native aquatic plants, M4, Column: Tribal and Cultural Resources		
P.A-8	Zuni, NPS Internal - TABLE A-1 Proposed Action, Row: Overwhelm ecosystem, C1, Column: Tribal and Cultural Resources	Adverse impact on contributing element of TCP for Pueblo of Zuni and Hopi Tribe, and potentially other associated Tribes, resulting from taking of life of affected fish and short-term impacts on water quality. Impacts would be reduced in proportion to the degree to which live removal and relocation or beneficial use of removed fish could be achieved prior to action.	Potential for the Pueblo of Zuni, Hopi Tribe, and other associated Tribes to perceive an adverse impact on a contributing element of TCPs resulting from taking of aquatic life and short-term impacts on water quality in small treated areas. Impacts would be reduced in proportion to the degree to which live removal and relocation or beneficial use of removed fish could be achieved prior to action.
P.A-8	Zuni, NPS Internal - TABLE A-1 Proposed Action, Row: Rapid response application, C2, Column: Tribal and Cultural Resources	Adverse impact on contributing element of TCP for Pueblo of Zuni and Hopi Tribe, and potentially other associated Tribes, resulting from taking of life of affected fish and short-term impacts on water quality. Impacts may be reduced in proportion to the degree to which live removal and relocation or beneficial use of removed fish could be achieved prior to action.	Potential for the Pueblo of Zuni, Hopi Tribe, and other associated Tribes to perceive an adverse impact on a contributing element of TCPs resulting from taking of aquatic life and short-term impacts on water quality in small treated areas. Impacts may be reduced in proportion to the degree to which live removal and relocation or beneficial use of removed fish could be achieved prior to action.
P.A-9	Zuni, NPS Internal - TABLE A-1 Proposed Action, Row: Application of registered piscicides, C3, Column: Tribal and Cultural Resources	Adverse impact on Tribal values resulting from taking of life of affected fish and short-term impacts on water quality. Impacts may be reduced in proportion to the degree to which live removal and relocation or beneficial use of removed fish could be achieved prior to action.	Potential for the Pueblo of Zuni, Hopi Tribe, and other associated Tribes to perceive an adverse impact on Tribal values resulting from taking of aquatic life and short-term impacts on water quality in small treated areas. Impacts may be reduced in proportion to the degree to which live removal and relocation or beneficial use of removed fish could be achieved prior to action.
P.A-9	Zuni, NPS Internal - TABLE A-1 Proposed Action, Row: Application of piscicides for fishery renovation, C4, Column: Tribal and Cultural Resources	Adverse impact on contributing element of TCP for Pueblo of Zuni and Hopi Tribe, and potentially other associated Tribes, resulting from taking of life of affected fish and short-term impacts on water quality. Impacts may be reduced in proportion to the degree to which live removal and relocation or beneficial use of removed fish could be achieved prior to action. Actions would not take place in Ribbon Falls and Deer Creek.	Potential for the Pueblo of Zuni, Hopi Tribe, and other associated Tribes to perceive an adverse impact on a contributing element of TCPs resulting from taking of aquatic life and short-term impacts on water quality in small treated areas. Impacts may be reduced in proportion to the degree to which live removal and relocation or beneficial use of removed fish could be achieved prior to action. Actions would not take place in Ribbon Falls and Deer Creek.
P.B-2	UCRC - TABLE B-1, row: Water Quality, column: Contributions of Past, Present, and Reasonably Foreseeable	Projected future changes in flow due to increased water demand (as a result of population growth and development), and decreased water supply, drought, and increased water temperature attributed to climate change could be the greatest contributors to adverse impacts on Colorado River flows, storage in Lakes Powell and Mead, and water quality	Past and present actions, especially construction and operation of Glen Canyon Dam, have reduced turbidity, moderated salinity levels and altered water temperature regimes by moderating variation in the Colorado River downstream of the dam. Future increases in population and development could increase diversions that reduce flows, or increase the potential for

	Future Actions on Cumulative Impacts	(temperature and salinity). The 2007 Interim Guidelines and related water conservation efforts, should provide more predictability in water supply to users in the Basin States (especially the Lower Basin) through 2026, and may also benefit water temperature and water quality in Lakes Powell and Mead. Future water depletions from Lake Powell including those from the proposed Lake Powell Pipeline Project and Page-LeChee Project could affect availability of water for release from Glen Canyon Dam and temperatures for release from Glen Canyon Dam.	urban and agricultural runoff, which could have adverse effects on water quality (National Research Council. 2007, Reclamation 2012a).
P.B-2	UCRC - TABLE B-1, row: Water Quality, column: Contributions to Cumulative Impacts of the LTEMP and CFMP	The LTEMP is consistent with the 2007 Interim Guidelines for annual water deliveries. The LTEMP would result in slightly greater summer warming and a slightly increased potential for bacteria and pathogens along shorelines. Flow- and non-flow-based control actions under the LTEMP and CFMP would not affect water quality, and, therefore would not contribute to cumulative impacts on water quality in the project area.	The LTEMP would result in slightly greater summer warming and a slightly increased potential for bacteria and pathogens along shorelines. Flow- and non-flow-based control actions under the LTEMP and CFMP would not affect water quality, and, therefore would not contribute to cumulative impacts on water quality in the project area.
P.B-2	UCRC - TABLE B-1, row: Water Quality, column: Contributions to Cumulative Impacts of Expanded Non-Native Aquatic Species Management Plan Proposed Action	The Proposed Action would not affect dam operations; therefore, no impacts on flow would occur. The Proposed Action would result in incremental changes to water quality that would be limited to the areas where control actions would occur and to the time period when actions would occur (hours or several days). No change would occur to sediment or turbidity downstream or Lake Mead. No change in baseline water quality conditions would result.	The Proposed Action would result in incremental changes to water quality that would be limited to the areas where control actions would occur and to the time period when actions would occur (hours or several days). No change would occur to sediment or turbidity downstream or Lake Mead. No change in baseline water quality conditions would result.
P.B-2	UCRC - TABLE B-1, row: Aquatic Ecology, column: Contributions of Past, Present, and Reasonably Foreseeable Future Actions on Cumulative Impacts	Aquatic resources would be affected by changes in flow due to increased water demand (as a result of population growth and development); decreased water supply, drought, and increased water temperature attributed to climate change; and other foreseeable actions (related to fish management and uranium mining). The potential for urban and agricultural runoff also increases with population growth, producing adverse effects on water quality, which could ultimately affect aquatic biota and habitat. Drought conditions (and actions such as the Lake Powell pipeline project) would result in lower reservoir elevations and benefits to aquatic resources associated with warmer	Aquatic resources would be affected by changes in flow due to increased water demand (as a result of population growth and development); decreased water supply, drought, and increased water temperature attributed to climate change; and other foreseeable actions (related to fish management and uranium mining). Future increases in population and development are expected to increase the potential for urban and agricultural runoff, which would have adverse effects on water quality and could ultimately affect aquatic biota and habitat. Drought conditions (and actions such as the Lake Powell pipeline project) would result in lower reservoir elevations and benefits to aquatic resources associated with warmer release temperatures. Warmer water temperatures,

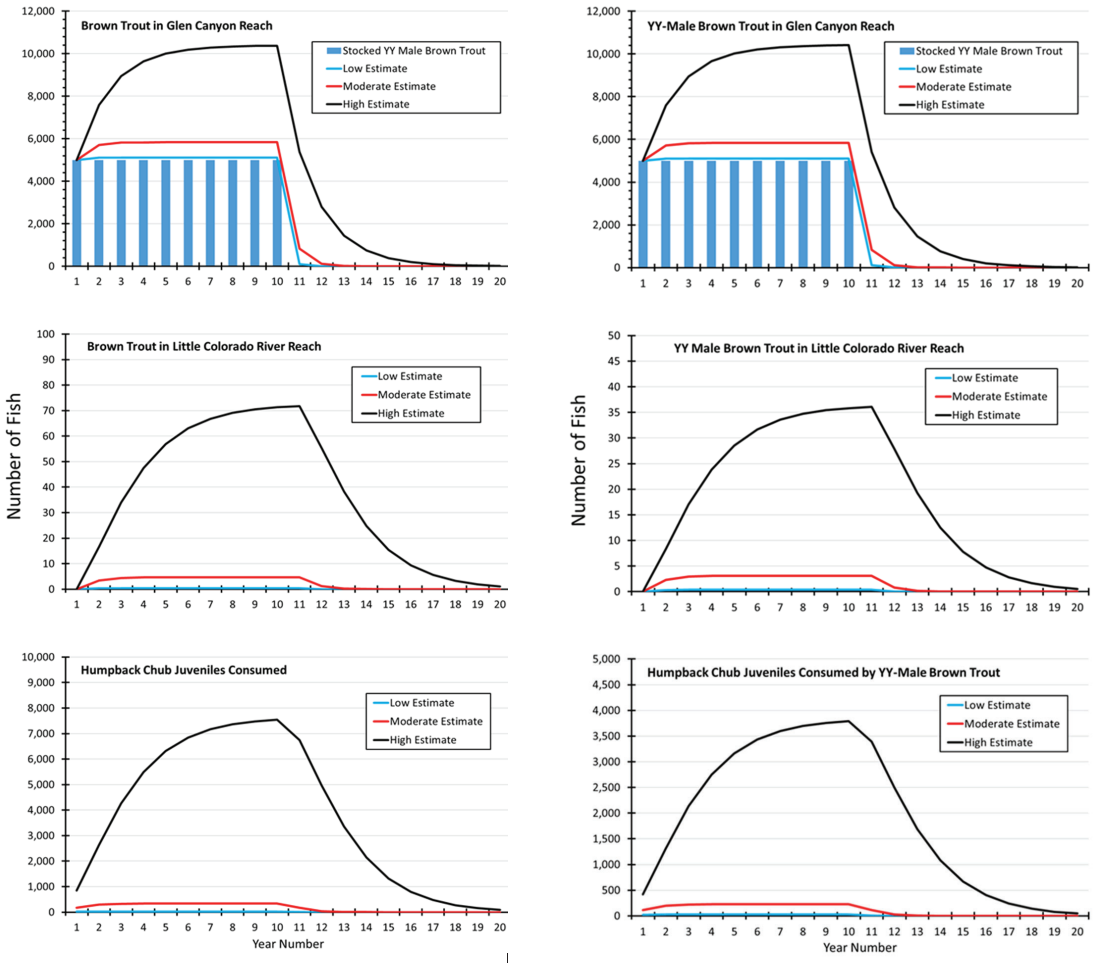
		release temperatures. Warmer water temperatures, however, could also result in adverse effects if they increase the distribution of non-native species adapted to warm water (e.g., fish parasites). 2007 Interim Guidelines determine annual volume and equalization years may increase trout production and river temperature both of which may impact humpback chub populations. Uranium mining could also have adverse (though local) effects on aquatic biota and habitats associated with ephemeral drainages (in the event of an accidental release of hazardous materials). Translocation of native fish species (humpback chub) from the Little Colorado River to other tributaries within the Grand Canyon would have a beneficial (protective) impact on aquatic resources.	however, could also result in adverse effects if they increase the distribution of non-native species adapted to warm water (e.g., fish parasites). 2007 Interim Guidelines determine annual volume and equalization years may increase trout production and river temperature both of which may impact humpback chub populations. Uranium mining could also have adverse (though local) effects on aquatic biota and habitats associated with ephemeral drainages (in the event of an accidental release of hazardous materials). Translocation of native fish species (humpback chub) from the Little Colorado River to other tributaries within the Grand Canyon would have a beneficial (protective) impact on aquatic resources.
	UCRC - TABLE B-1, row: Tribal and Cultural Resources, column: Contributions to Cumulative Impacts of Expanded Non-Native Aquatic Species Management Plan Proposed Action	No adverse impacts on archaeological sites are anticipated. The Proposed Action's contribution to cumulative impacts on cultural resources would potentially increase impacts to the Canyons as a TCP if lower tier actions are not successful and lethal methods of control cannot be conducted with beneficial use. Chemical control actions, if used, would also negatively impact the quality of water and overall health of the canyon, which is characterized by species diversity for some associated Tribes and includes both native and non-native species.	No adverse impacts on archaeological sites are anticipated. The Proposed Action's contribution to cumulative impacts on cultural resources would potentially increase impacts to the Canyons as a TCP if lower tier actions are not successful and lethal methods of control cannot be conducted with beneficial use. Chemical control actions, if used, would have short term (up to several weeks) impacts on water quality in small treated areas.
P.B-3	UCRC - TABLE B-1, row: Socioeconomics and environmental justice, column: Contributions to Cumulative Impacts of Expanded Non-Native Aquatic Species Management Plan Proposed Action	Implementation of the control actions under the Proposed Action would have negligible adverse economic impact, but if successful, would help prevent degradation of the fishery and provide economic benefits that would likely be minor. Although not expected, there is the potential for the collective or repeated use of some or all of the potential actions of the Proposed Action to harm the Lees Ferry rainbow trout fishery or result in a negative public perception of the fishery and damage to the local economy that relies on the fishery. Monitoring, off-ramps, and mitigation would reduce the likelihood of this impact. Environmental justice impacts would result from Tribal objections to taking of life of fish and minor short-term impacts on water quality, if lower tier control actions are not successful. Live removal and relocation or beneficial use of fish may reduce environmental justice impacts.	Implementation of the control actions under the Proposed Action would have negligible adverse economic impact, but if successful, would help prevent degradation of the fishery and provide economic benefits that would likely be minor. Although not expected, there is the potential for the collective or repeated use of some or all of the potential actions of the Proposed Action to harm the Lees Ferry rainbow trout fishery or result in a negative public perception of the fishery and damage to the local economy that relies on the fishery. Monitoring, off-ramps, and mitigation would reduce the likelihood of this impact. Environmental justice impacts would result from Tribal objections to taking of aquatic life if lower tier control actions are not successful. Live removal and relocation or beneficial use of fish may reduce environmental justice impacts.

P.C-1 L.26	AGFD, anglers - Appendix C - C.1- MECHANICAL DISRUPTION OF EARLY LIFE STAGE HABITATS (ACTION M1; TIER 2)	Off-Ramp. If mechanical disruption is determined to be ineffective, if adequate funding is not available, or if unacceptable impacts to other resources (such as the rainbow trout fishery, native/endangered fish, etc.) are observed then action may be suspended temporarily or permanently depending upon the evidence.	Off-Ramp. If mechanical disruption is determined to be ineffective, if adequate funding is not available, or if unacceptable impacts on native fish, rainbow trout (including an unexpected severe reduction in rainbow trout spawning), or other important resources are expected or observed, then action may be suspended temporarily or permanently depending upon the evidence.
P.C-1 L.38	Jim Strogen comment regarding LTEMP BO – Appendix C - C.2 MECHANICAL REMOVAL (ACTION M2; TIERS 1, 2, OR 3) C.2.1 Triggers - *Trigger to Initiate Action.* 1a.	LTEMP triggers for mechanical removal of trout at the Little Colorado River confluence have been exceeded and mechanical removal is being implemented or has been proposed for the following year;	LTEMP triggers for mechanical removal of trout at the Little Colorado River confluence have been exceeded[5] and mechanical removal is being implemented or has been proposed for the following year; Footnote #5 added: Several LTEMP Tier 1 actions specified in the LTEMP EIS (DOI 2016) must prove to be ineffective (i.e., fail to slow or reverse the decline in the humpback chub population) before the LTEMP Tier 2 action of mechanical removal is implemented. LTEMP Tier 1 actions include expanded translocation of humpback chub within the Little Colorado River, and implementation of a head-start program for larval humpback chub.
P.C-2 L.1	USFWS - Appendix C - C.2 MECHANICAL REMOVAL (ACTION M2; TIERS 1, 2, OR 3) Trigger 1b.	Brown trout are a contributing proportion of the fish predators in the Little Colorado River reach (e.g., 6 adult brown trout caught in the current or previous year in the Juvenile Chub Monitoring (JCM) reach (RM 63.5-65.2);	Brown trout are a contributing proportion of the fish predators in the Little Colorado River reach (e.g., 6 adult brown trout caught in the current or previous year in the Juvenile Chub Monitoring (JCM) reach (RM 63.5-65.2);[6] [6] The number of 6 brown trout was chosen for a definitive trigger, and though the number appears low, it represents the actual number caught, but for this type of sampling protocol it would indicate the presence of a much greater number of brown trout in this area. It includes brown trout caught in the Juvenile Chub Monitoring (JCM) reach during any kind of monitoring or mechanical removal trip. If mechanical removal is being implemented in full, and a total of 36 passes are made, we are likely to catch at least 6 and likely more than 15, if the moderate or high risk assumptions are correct; however, if we catch 6 brown trout in the JCM reach in only a few monitoring occasions, before mechanical removal is triggered at the Little Colorado River, we know the brown trout population there has increased to the point where an upstream source is likely, which must be addressed.
P.C-4 L.5	USFWS – Appendix C - C.3 INTRODUCTION OF	Introduction of YY-male fish is considered an experimental action (outside of tiers) for medium-very high risk species that may be considered if brood stock exists and if experimental evidence and modeling indicate it may be	Introduction of YY-male fish is considered an experimental action (outside of tiers) for medium-very high risk species that may be considered if brood stock exists and if experimental evidence and modeling indicate it may be effective. Brown trout YY-male stocking

	YY-MALE FISH (ACTION B1)	effective and other actions are shown or projected to be ineffective. Brown trout YY-male stocking would be most effective if implemented when the population is relatively small. Although it could still be effective at larger population sizes, it would take longer to reduce the wild population, and, if that population is large (e.g., >10,000 adults), a higher number of YY males must be stocked for greatest effect. Higher stocking rates could create an increased risk to downstream native and endangered fish. Based on modeling of brook trout in Idaho (Schill et al. 2017), it is expected that a removal rate of 15% (potentially achievable with incentivized harvest) and stocking of YY males at > 50% of the wild population could achieve elimination of the population in 10 years; stocking at a lower percentage would extend that time.	would be most effective if implemented when the population is relatively small. Although it could still be effective at larger population sizes, it would take longer to reduce the wild population, and, if that population is large (e.g., >10,000 adults), a higher number of YY males must be stocked for greatest effect. Higher stocking rates could create an increased risk to downstream native and endangered fish. Based on modeling of brook trout in Idaho (Schill et al. 2017), it is expected that a removal rate of 15% (potentially achievable with incentivized harvest) and stocking of YY males at > 50% of the wild population could achieve elimination of the population in 10 years; stocking at a lower percentage would extend that time.
P.C-4 L.19	USFWS and AGFD – comments – Appendix C - C.3.1 Triggers	Trigger to Initiate Action. This action would be considered for brown trout if the number of wild brown trout adults (>350 mm) is more than 500. The action would be more effective if the stocking level is 25 to 50% of the existing wild population. A maximum of 5,000 adult YY-male brown trout, or equivalent number of juveniles (estimated to be 10,000 based on assumed juvenile survival rates), would be stocked into the Glen Canyon reach annually. This number represents a conservative level of risk to humpback chub if survival, movement, and predation rates are at high-risk levels (see Table C-1 for values associated with different risk levels). If survival, movement and predation rates were found to be at the lower end of the risk levels, risk to humpback chub would also be lower than modeled.	Trigger to Initiate Action. This action would be considered for brown trout if experimental evidence and modeling indicate the action may be effective, and wild brown trout adults (>350 mm) are present in the reach. The action would be more effective if the stocking level is 25 to 50% of the existing wild population. A maximum of 5,000 adult YY-male brown trout, or equivalent number of juveniles (estimated to be 10,000 based on assumed juvenile survival rates), would be stocked into the Glen Canyon reach annually. This number represents a conservative level of risk to humpback chub if survival, movement, and predation rates are at high-risk levels (see Table C-1 for values associated with different risk levels). If survival, movement and predation rates were found to be at the lower end of the risk levels, risk to humpback chub would also be lower than modeled.
P.C-4 L.28	USFWS – Appendix C - C.3.1 Triggers	Trigger to Stop Action. If wild brown trout adults in the Glen Canyon reach have decreased to below measurable levels for 3 years, then YY-male introduction would cease unless the population increases to the initiation trigger of 500 adults. Once stocking of YY-male brown trout ceases, YY males would persist in the population for a number of years, continuing to drive the number of XY-males down to eventually eradicate the population.	Trigger to Stop Action. If wild brown trout adults in the Glen Canyon reach are not observed during monitoring for 3 years, then YY-male introduction may cease. Once stocking of YY-male brown trout ceases, YY males may persist in the population for a few years, continuing to drive the number of XY-males down to eventually eradicate the population.
P.C-6 L.9	USFWS – TABLE B-1, Appendix C – only Moderate and High-	TABLE C-1 Estimated Input Parameters for Modeling Effect of Stocked YY-Male Brown Trout on Predation of	TABLE C-1 Estimated Input Parameters for Modeling Effect of Stocked YY-Male Brown Trout on Predation of Humpback Chub under Low-, Moderate-, and High-Risk Assumptions

<table>
<tr>
<td></td>
<td>Risk columns changed and only footnote c changed. (Low-Risk column unchanged and footnotes a, b and d unchanged).</td>
<td>Humpback Chub under Low-, Moderate-, and High-Risk Assumptions
<table>
<tr><th>Parameter</th><th>Moderate-Risk</th><th>High-Risk</th></tr>
<tr><td>Number of YY-male brown trout stocked[a]</td><td>5,000[b]</td><td>5,000</td></tr>
<tr><td>3-month brown trout survival rate</td><td>0.62[b]</td><td>0.85</td></tr>
<tr><td>3-month proportion of stocked brown trout moving from Glen Canyon reach to Little Colorado River reach[c]</td><td>0.0012[b]</td><td>0.0016</td></tr>
<tr><td>3-month effect on humpback chub at Little Colorado River[d]</td><td>16.15</td><td>25.5</td></tr>
</table>
[c] Four times the estimated movement rate to reaches IVa and IVb (Korman et al. 2015) to represent number of brown trout within the entire Little Colorado River reach. The reaches monitored by Korman et al. (2015) represent about 28% of the entire Little Colorado River reach.</td>
<td>
<table>
<tr><th>Parameter</th><th>Moderate-Risk</th><th>High-Risk</th></tr>
<tr><td>Number of YY-male brown trout stocked[a]</td><td>5,000</td><td>5,000</td></tr>
<tr><td>3-month brown trout survival rate</td><td>0.62[b]</td><td>0.85</td></tr>
<tr><td>3-month proportion of stocked brown trout moving from Glen Canyon reach to Little Colorado River reach[c]</td><td>0.0008</td><td>0.0008</td></tr>
<tr><td>3-month effect on humpback chub at Little Colorado River[d]</td><td>13.6</td><td>25.5</td></tr>
</table>
[c] Four times the estimated movement rate to reaches IVa and IVb (Korman et al. 2016) to represent number of brown trout within the entire Little Colorado River reach. The reaches monitored by Korman et al. (2016) represent about 28% of the entire Little Colorado River reach.</td>
</tr>
<tr>
<td>P.C-6 L.20</td>
<td>USFWS – Appendix C - C.3.3 Modeled Impacts of YY-Male Fish Introduction</td>
<td>The modeled estimates of the annual number of YY-male brown trout in the Glen Canyon and Little Colorado River reaches and humpback chub eaten by stocked YY trout in the Little Colorado River reach during the 20-year period under the various risk scenarios are presented in Figure C-1. Modeling indicated that annual stocking of 5,000 adult YY-male brown trout into the Glen Canyon reach for a 10-year period could result in average annual consumption over a 20-year period of 13, 169, and 3,813 juvenile humpback chub for low-, moderate-, and high-risk scenarios, respectively. Total consumption of juvenile humpback chub over a 20-year period was estimated to be 269, 3,379, and 76,259 for the low-, moderate-, and high-risk scenarios, respectively. The model estimated that stocked YY-male brown trout would consume fewer than 30 juvenile humpback chub in any given year under the low-risk scenario and fewer than</td>
<td>The modeled estimates of the annual number of YY-male brown trout in the Glen Canyon and Little Colorado River reaches and humpback chub eaten by stocked YY trout in the Little Colorado River reach during the 20-year period under the various risk scenarios are presented in Figure C-1. Modeling indicated that annual stocking of 5,000 adult YY-male brown trout into the Glen Canyon reach for a 10-year period could result in average annual consumption over a 20-year period of 13, 113, and 1,915 juvenile humpback chub for low-, moderate-, and high-risk scenarios, respectively. Total consumption of juvenile humpback chub over a 20-year period was estimated to be 269, 2,254, and 38,301 for the low-, moderate-, and high-risk scenarios, respectively. The model estimated that stocked YY-male brown trout could consume fewer than 30 juvenile humpback chub in any given year under the low-risk scenario and up to 225 juvenile humpback chub under the medium-risk scenario (Figure C-1). Under the high-risk scenario, approximately 40-3,800 juvenile humpback chub were estimated to be consumed annually during the 20-</td>
</tr>
</table>

		350 juvenile humpback chub under the medium-risk scenario (Figure C-1). Under the high-risk scenario, approximately 100-7,500 juvenile humpback chub were estimated to be consumed annually during the 20-year period by YY-male brown trout stocked in the Glen Canyon reach and emigrating to the Little Colorado River confluence (Figure C-1).	year period by YY-male brown trout stocked in the Glen Canyon reach and emigrating to the Little Colorado River confluence (Figure C-1).
P.C-6 L.34	USFWS – Appendix C - C.3.3 Modeled Impacts of YY-Male Fish Introduction	Estimated YOY humpback chub production in the Little Colorado River ranges from approximately 5,000 to 45,000 per year (Yackulic 2018b). Thus, it is estimated that stocked brown trout could consume 17-100% of the annual humpback chub production in a given year under the high-risk assumptions, 0.8-7% under the medium-risk assumptions, and 0.1 to 0.5% of humpback chub production under the low-risk assumptions.	Estimated YOY humpback chub production in the Little Colorado River ranges from approximately 5,000 to 45,000 per year (Yackulic 2018b). Thus, it is estimated that stocked brown trout could consume 8-76% of the annual humpback chub production in a given year under the high-risk assumptions, 1-5% under the medium-risk assumptions, and 0 to 1% of humpback chub production under the low-risk assumptions.

P. C-7	Based on USFWS consultation – recomputed graphs – note y axis scale changes – Appendix C - C.3.3 Modeled Impacts of YY-Male Fish Introduction – FIGURE C-1 Modeled Annual Low, Moderate, and High Estimates of YY-Male Brown Trout in Glen Canyon Reach (Upper Panel), YY-Male Brown Trout in the Little Colorado River Reach (Middle Panel), and Number of Juvenile Humpback Chub Consumed by YY-Male Trout Over a 20-Year Period (Lower Panel). Revised figure reflects revised parameters.	

	USFWS – Appendix C – deleted as part of update for consistency with Biological Assessment	No chemical treatments, sonic concussive treatments, or mechanical harvesting of aquatic plants and algae would occur within 100 m (330 ft) of known locations of Kanab ambersnail. All piscicide or herbicide use would be subject to NPS review and approval processes in strict adherence to applicable regulations and guidelines, and would be implemented at appropriate water levels to ensure that chemicals would not come into contact with ambersnails. Before any action would occur in the vicinity of known ambersnail populations, surveys would be conducted, and ambersnails in potentially affected areas would be moved to higher locations within the habitat area if needed to avoid impacts.	
P.C-8-C-9	USFWS – Appendix C – updated for consistency with Biological Assessment	Measures that would be utilized to minimize impacts on the California condor and Mexican spotted owl include: • To reduce noise impacts on sensitive wildlife and areas with natural or wilderness characteristics when flying to and from the work area, helicopters would maintain a minimum 2,000 ft altitude where possible, per FAA Advisory Circular 91-36D Visual Flight Rules (VFR) Flight Near Noise-Sensitive Areas. • Flights would occur prior to 10 am whenever possible because condors are less active in the morning hours • Pilots would minimize aircraft use along the rim and cliffs to the greatest extent possible. Helicopter pilots will be encouraged to use quieter maneuvers (ones that produce less noise), wherever possible, according to the Fly Neighborly training available at https://go.usa.gov/xQPCW and https://www.rotor.org/operations/flyneighborly.aspx • Except for authorized biologists trained in survey techniques, helicopters and fixed-wing aircraft will avoid operating within 1,000 feet of eagle nests during the breeding season, except where eagles have demonstrated tolerance for such activity. Potentially disruptive activities will be minimized in the eagles' direct flight path between their nest and roost sites and important foraging areas. Aircraft corridors will be located no closer than 1,000 ft vertical or horizontal distance from communal roost sites, where possible.	Below are the specific best management practices and measures that would be used to avoid or mitigate impacts to wetlands for action P4: 1. To ensure effects to hydrology, water quality and geomorphology, the time periods of impact will be minimized. he construction period would be for a maximum of 2 weeks and periodic dewatering would be for a maximum of 2 weeks, with refill and recovery of water quality conditions taking a maximum of 7 days after the water control structure is reclosed. 2. To ensure negligible to minor effects to non-target fauna (primarily native fish and herpetiles), pre-treatment surveying would occur with removal and relocation of a majority of non-target organisms prior to construction and any scheduled periodic draining. 3. During the construction period, heavy equipment would take measures to minimize soil and plant root disturbance in the wetland fringe vegetation and measures will be employed to prevent or control spills of fuels, lubricants, or other contaminants from entering the waterway or wetland. Action is consistent with state water quality standards and Clean Water Act Section 401 certification requirements. Appropriate erosion and siltation controls will be maintained during construction, and exposed soil will be permanently stabilized at the earliest practicable date. Structure or fill will be properly maintained so as to avoid adverse impacts on aquatic environments or public safety. 4. To minimize the effects of cut and fill and erosion, the disturbed area would be minimized with a maximum of 3400 sq feet

		• Aircraft associated with this project would stay at least 1 mi (1.6 km) away from active condor nest locations and vicinities except when human safety would be compromised. The active nesting season is February 1 – September 30. These dates may be modified based on the most current information regarding condor nesting activities (roosting, fledging, etc.) and coordination with GCNP's Wildlife Program Manager, Section 7 Coordinator, and FWS. • Helicopters will stay at least 1,200 ft (366 m) away from condors in the air, or on the ground or cliffs unless safety concerns override this restriction. • If airborne condors approach aircraft, aircraft will give up airspace to the extent possible, as long as this action does not jeopardize safety. • In order to minimize noise disturbance within Mexican spotted owl Protected Activity Centers, helicopters will stay at least 1,200 ft (366 m) away from Protected Activity Centers between March 1 and August 31. If non-breeding is inferred or confirmed during approved-protocol surveys in a Protected Activity Center during the breeding season, restrictions on noise disturbances should be relaxed depending on the nature and extent of the proposed disturbance. • On a case-specific basis, NPS will assess the potential for noise disturbance to nesting owls. Breeding-season restrictions will be considered if noise levels are estimated to exceed 69 dBA (A-weighted noise level; approximately 80 dBO [owl-weighted noise level, FWS 2012]) consistently (i.e., >twice/hour) or for an extended period of time (>1 hr) within 165 ft (50 m) of nesting sites (if known) or within entire Protected Activity Center if nesting sites are not known. Other measures to avoid and mitigate sound impacts would include: • Where possible, pumps and generators that do not exceed 60 dBA, at 50 feet, will be selected, per the NPS Audio Disturbances rule (36 CFR 2.12).	disturbed for the placement of the control structure, and a maximum of 150 cubic yards disturbed in the dredging. Cut and fill material would not be stockpiled, and the dredged material would be redistributed onto the adjacent cobble bar where sands would be redistributed by the next HFE and the gravels/cobbles would assist in further armoring this natural and historic feature of the river. . 5. To minimize the effects on vegetation, wetland fringe vegetation would be monitored with photo documentation before and after construction and before and after the scheduled periodic dewatering actions. This would ensure that effects to wetland fringe vegetation are minimized and that the affected area continues to be less than 0.25 acres. Where plantings or seeding are required, native plant material will be obtained and used in accordance with NPS policies and guidance. Management techniques will be implemented to foster rapid development of target native plant communities and to eliminate invasion by exotic or other undesirable species. 6. There are no wild and scenic river designations or coastal zone management areas in this project area. 7. Measures to avoid impacts to endangered species are addressed below and in appendix D, the biological opinion. 8. Measures to avoid impacts to historic properties are addressed in the programmatic agreement in Appendix E. Below are the specific conservation measures that would be used to avoid or mitigate impacts to federally listed or special status native species. CM-1. Pre-Treatment Surveys to Avoid Impacts to Endangered Fish: As necessary, surveys would be conducted in the immediate area of a control action for endangered fish prior to initiation of the action. If endangered fish are found, and unless otherwise specified, NPS will assess whether to continue with the action and will apply the appropriate conservation measures as outlined below. Measures in CM-5 and CM-6 would be used to minimize impacts from the survey itself. CM-2 Measures to Avoid Impacts to Kanab Ambersnail: No chemical treatments or mechanical removal of fish or aquatic vegetation would occur within 100 m (330 ft) of known locations of Kanab ambersnail. Currently Kanab ambersnail is only known from two locations in the action area, Elves Chasm and Vasey's Paradise. All piscicide or herbicide use would be subject to NPS review and approval

		• When possible, work will be limited to the hours of 6:00 am - 10:00 pm, to reduce disturbance during quiet hours at established campsites, marked by signs, along the Colorado River below the Glen Canyon Dam. This may not be possible for mechanical removal. • Where possible, boats that do not exceed 75 dBA, at shoreline, will be selected, per the NPS maximum boat noise rule (36 CFR 3.15).	processes in strict adherence to applicable regulations and guidelines, and would be implemented at appropriate water levels to ensure that chemicals would not come into contact with ambersnails. CM-3. Measures to Minimize Impacts on California Condor, Mexican Spotted Owl, Eagles, and Riparian Birds: ● Prior to the start of project activities for the year, GCNP's Wildlife Department will be contacted for any new information related to Mexican spotted owls, California condors, and eagles near the project area. Sensitive species maps will be updated annually with any new information to ensure consistency with the above measures and will be referenced when annual work plans are developed. ● Camping will not occur within 0.25mi of PAC boundaries during the breeding season (March 1 – August 31), until surveys can be done to locate nests. Such situations will be coordinated with the GCNP's Wildlife Department. ● Crews will not exceed 12 people in Mexican spotted owl PACs or suspected occupied areas during the breeding season. ● Any crew access necessary within 0.25 mi of an active condor nest site during the breeding season will be limited to established roads and trails. If access off designated roads or trails or camping is necessary during the breeding season, only activities that occur greater than 0.25 mi from any known or suspected nest area may be conducted. Such situations will be coordinated with GCNP's Wildlife Department. ● Planned projects involving mechanized equipment will not occur within 0.5 mi of active condor nesting sites during the breeding season (February 1 – September 30). ● Flights would occur prior to 10 am whenever possible because condors are less active in the morning hours. ● Aircraft associated with this project would stay at least 1 mi (1.6 km) away from active condor nest locations and vicinities except when human safety would be compromised. The active nesting season is February 1 – September 30. These dates may be modified based on the most current information regarding condor nesting activities (roosting, fledging, etc.) and coordination with GCNP's Wildlife Program Manager, Section 7 Coordinator, and the Service.

			● Helicopters will stay at least 1,200 ft (366 m) away from condors in the air, or on the ground or cliffs unless safety concerns override this restriction. ● If airborne condors approach aircraft, aircraft will give up airspace to the extent possible, as long as this action does not jeopardize safety. ● To reduce noise impacts on sensitive wildlife and areas with natural or wilderness characteristics when flying to and from the work area, helicopters would maintain a minimum 2,000 ft altitude where possible, per FAA Advisory Circular 91-36D Visual Flight Rules (VFR) Flight near Noise-Sensitive Areas. ● Pilots would minimize aircraft use along the rim and cliffs to the greatest extent possible. Helicopter pilots will be encouraged to use quieter maneuvers (ones that produce less noise), wherever possible, according to the Fly Neighborly training available at: https://go.usa.gov/xQPCW and https://www.rotor.org/operations/flyneighborly.aspx ● In order to minimize noise disturbance within Mexican spotted owl PAC, helicopters will stay at least 1,200 ft (366 m) away from PAC between March 1 and August 31. If non-breeding is inferred or confirmed during approved-protocol surveys in a Protected Activity Center during the breeding season, restrictions on noise disturbances should be relaxed depending on the nature and extent of the proposed disturbance. ● On a case-specific basis, NPS will assess the potential for noise disturbance to nesting owls. Breeding-season restrictions will be considered if noise levels are estimated to exceed 69 dBA (A-weighted noise level; approximately 80 dBA [owl-weighted noise level, Service 2012]) consistently (i.e., >twice/hour) or for an extended period of time (>1 hr) within 165 ft (50 m) of nesting sites (if known) or within entire Protected Activity Center if nesting sites are not known. ● Except for authorized biologists trained in survey techniques, helicopters and fixed-wing aircraft will avoid operating within 1,200 ft of known eagle nests during the breeding season, except where eagles have demonstrated tolerance for such activity. Potentially disruptive activities will be minimized in the eagles' direct flight path between their nest and roost sites and important foraging areas. Aircraft corridors will be located no closer than 1,200 ft vertical or horizontal distance from known communal roost sites, where possible.

			● No helicopter landing zones will be used in suitable breeding habitat for southwestern willow flycatcher, Ridgway's (Yuma clapper) rail or western yellow-billed cuckoo during their respective breeding seasons. CM-4. Additional Measures to Avoid and Mitigate Disturbance to Riparian Birds, California condors, and eagles: ● Where possible, pumps, heaters and generators that do not exceed 60 dBA, at 50 ft, will be selected, per the NPS Audio Disturbances rule (36 CFR 2.12). ● Where possible, boats that do not exceed 75 dBA, at shoreline, will be selected, per the NPS maximum boat noise rule (36 CFR 3.15). Pressure washers will also be selected for action M1 to conform to this noise rule. ● Where possible crews traveling through riparian areas to get to treatment sites will use established trails and campsites. CM-5. Mechanical Removal/Electrofishing Conservation Measures (M2): ● Electrofishing gear will be set to avoid injury to all fishes, including rainbow trout in Lees Ferry; the least-intensive electrofishing settings that effectively stuns and captures fish will be used in most cases. For example, during tributary electrofishing in Grand Canyon, a pulsed-DC at a frequency of 30-40 Hz (300-350 volts) has proven to be sufficient in minimizing mortality to both non-native trout and native fishes. However, if no native or non-target species are present in backwater or off-channel areas, settings may be altered to maximize the capture of target species. ● In tributaries where humpback chub have been released, electrofishing equipment use will be minimized in large-volume, deep pools where gear is less effective in capturing fish, and where humpback chub tend to congregate. ● In tributaries or small backwaters, during multiple-pass depletion electrofishing, native fish will be retained in holding areas between passes, or released in a manner that will minimize the likelihood of repeated electrofishing (i.e., away from the sampling areas). ● Non-target fish captured using electrofishing will be monitored in buckets, and gear settings would be adjusted if sufficient shock recovery is not observed. ● Crew members will be sufficiently trained in electrofishing techniques.

			CM-6. General Fish Handling: ● Trammel net use will be minimized when possible, and will not be used if water temperatures exceed 20°C, in areas with known presence of ESA-listed fishes. Trammel nets would be checked every 2 hours or less. ● "General Guidelines for Handling Fish" published by the USGS-GCMRC to minimize injury to non-target fish would be followed during all field projects (Persons et al. 2013). ● During sampling efforts, all native fish will be processed first and handling time on captured listed fish will be minimized whenever possible. ● If incidental mortality occurs, humpback chub and razorback sucker otoliths will be extracted and preserved (if feasible) in 100% ethanol, otherwise the entire fish will be preserved as described in Persons et al. (2013) and deposited into GCNP's museum. ● In areas with known presence of ESA-listed fishes, and subject to NPS regulations, no bait, or an artificial or natural substance that attracts fish by scent and/or flavor (i.e., live or dead minnows/small fish, fish eggs, roe, worms, or human food), would be used by anglers participating in non-native fish control efforts. If angling is used in any mechanical removal efforts in GCNP, then barbless hooks would be used for trout removal activities in areas with known presence of listed fishes. CM-7. Aquatic Invasive Species (AIS) Prevention Measures ● Standard quarantine/hatchery pathogen and disease testing and treatment procedures will be followed to prevent the transfer of AIS from one water to another during live transport of non-native fish species; currently only proposed for green sunfish removed from the 12-Mile Slough in GCNRA to Lake Powell. ● To prevent inadvertent movement of disease or parasitic organisms among aquatic sites, research and management activities shall conform to the Declining Amphibians Population Task Force Field Work Code of Practice (www.nrri.umn.edu/NPSProtocol/pdfs/Amphibians/Appendix%20B.pdf), with the exception that 10% bleach solution or 1% quaternary ammonia should be used to clean equipment rather than 70% ethanol. Abiding by this code will effectively limit the potential spread of pathogens via fish sampling equipment. CM-8. Conservation Measures for Southwestern Willow Flycatcher

			● Surveys of southwestern willow flycatchers through the project area will be conducted periodically (typically every 2 years) as budget allows or in accordance with the Service's 2016 LTEMP Biological Opinion (Service 2016c). ● To ensure that staff have the most current information on flycatchers prior to the start of any management activities under the Proposed Action, the GCNP's wildlife department would be contacted for suitable breeding habitat maps and any new occurrence near the project area. ● Southwestern willow flycatcher location, survey maps, and suitable breeding habitat maps will be updated following any new information to ensure consistency with the above measures and will be referenced when annual work plans are developed. ● Suitable southwestern willow flycatcher breeding habitat, as defined in the Southwestern Willow Flycatcher Recovery Plan (Service 2002a), will be avoided for activities which may cause disturbance including Actions M1 (if using pressure sprayer), P1, P5, C1, C2, C3, C4, and C5 (if using noise generating equipment) during the breeding season (May 1-August 31). If there is a need to move forward with any of these actions in suitable breeding habitat during breeding season, then clearance surveys for southwestern willow flycatcher will be conducted during breeding season in the immediate action area to determine if it is occupied or unoccupied prior to the action. NPS will conduct clearance surveys as close to the start of the action as possible, preferably within 1-2 days. If the area is occupied or NPS is unable to conduct clearance surveys, then either the action will not occur during the breeding season or NPS will communicate with the Service AESO prior to the action to determine an appropriate buffer if there is still a reason to consider going forward in this location during that time. ● No helicopter landing zones for this Proposed Action will be used in suitable breeding habitat for southwest willow flycatcher during the breeding season unless a clearance survey in the past year has determined it is unoccupied. If the area is occupied or NPS is unable to conduct clearance surveys, then either the action will not occur during the breeding season or NPS will communicate with AESO prior to the action to determine an appropriate buffer if there is still a reason to consider going forward in this location during that time. ● No camping or sustained activities would occur by fisheries crews for this Proposed Action, except at already established campsites, in

			suitable breeding habitat within the breeding season (May 1 – August 31) and travel through these areas will be minimized during this season. ● Habitat modification of riparian areas in this species' suitable breeding habitat would not occur as part of management activities under the Proposed Action. CM-9. Conservation Measures for Ridgway's (Yuma Clapper) rail (primarily GCNP) ● Surveys of Ridgway's rail through the project area will be conducted periodically (typically every 3 years) as budget allows or in accordance with the LTEMP biological opinion. ● To ensure that staff have the most current information on Ridgway's rail prior to the start of any management activities under the Proposed Action, the park's wildlife department would be contacted for suitable breeding habitat maps any new occurrence near the project area. ● Ridgway rail locations, survey maps, and suitable breeding habitat will be updated following any new information to ensure consistency with the above measures and will be referenced when annual work plans are developed. ● Suitable breeding habitat will be avoided for activities which may cause disturbance including Actions M1 (if using pressure sprayer), P1, P5, C1, C2, C3, C4 and C5 (if using noise generating equipment) during the breeding season (March 1-July 1). If there is a need to move forward with any of these actions in suitable breeding habitat during breeding season, then clearance surveys for the rail will be conducted during breeding season in the immediate action area to determine if it is occupied or unoccupied prior to the action. NPS will conduct clearance surveys as close to the start of the action as possible, preferably within 1-2 days. If the area is occupied, then either the action will not occur during the breeding season or NPS will communicate with the Service prior to the action if there is still a reason to consider moving forward in this location and during that time. ● No helicopter landing zones for this Proposed Action will be used in suitable breeding habitat for Ridgway rail during the breeding season (March 1-July 1) unless a clearance survey in the past year has determined it is unoccupied. If the area is occupied or NPS is unable to conduct clearance surveys, then either the action will not occur during the breeding season or NPS will communicate with the Service AESO prior to the action to determine an appropriate buffer if there is

			still a reason to consider going forward in this location during that time. ● No camping or sustained activities would occur by fisheries crews for this Proposed Action, except at already established campsites, in suitable breeding habitat within the breeding season (May 1 – August 31) and travel through these areas will be minimized during this season especially in dense riparian vegetation where cattails and/or bulrush are present. ● Habitat modification of riparian areas in this species' suitable breeding habitat would not occur as part of management activities under the Proposed Action. CM-10. Conservation Measures for Western Yellow-Billed Cuckoo (primarily GCNP) ● As funding allows, GCNP would conduct surveys through the project area for the western yellow-billed cuckoo, typically every 3 years. Such surveys may be combined with surveys for other breeding birds and/or southwestern willow flycatchers. ● To ensure that staff have the most current information on cuckoos prior to the start of any management activities under the Proposed Action, GCNP's wildlife department would be contacted for suitable breeding habitat maps and any new occurrence near the project area. ● Western yellow-billed cuckoo locations, survey maps, and suitable breeding habitat maps will be updated following any new information to ensure consistency with the above measures and will be referenced when annual work plans are developed. ● Suitable western yellow-billed cuckoo breeding habitat will be avoided for activities which may cause disturbance including Actions M1 (if using pressure sprayer), P1, P5, C1, C2, C3, C4, and C5 (if using noise generating equipment) during the breeding season (May 15 – September 15. If there is a need to move forward with any of these actions in suitable breeding habitat during breeding season, then clearance surveys for the cuckoo will be conducted during breeding season in the immediate action area to determine if it is occupied or unoccupied prior to the action. NPS will conduct clearance surveys as close to the start of the action as possible, preferably within 1-2 days. If the area is occupied or NPS is unable to conduct clearance surveys, then either the action will not occur during the breeding season or NPS will communicate with the Service AESO prior to the action to determine an appropriate buffer if there is still a reason to consider going forward in this location during that time.

			● No helicopter landing zones for this Proposed Action will be used in suitable breeding habitat for cuckoos during the breeding season (May 15 – September 15) unless a clearance survey in the past year has determined it is unoccupied. If the area is occupied or NPS is unable to conduct clearance surveys, then either the action will not occur during the breeding season or NPS will communicate with the Service AESO prior to the action to determine an appropriate buffer if there is still a reason to consider going forward in this location during that time. ● No camping or sustained activities would occur by fisheries crews for this Proposed Action, except at already established campsites, in suitable breeding habitat within the breeding season (May 15 – September 15) and travel through these areas will be minimized during this season. ● Habitat modification of riparian areas in this species' suitable breeding habitat would not occur as part of management activities under the Proposed Action. CM-11. Conservation Measures When Using Piscicides (Rotenone, Antimycin or Ecosystem Cycling Treatments, Action C1, C2, C3, C4): ● For Actions C1, C2, C3, and C4, if any humpback chub or razorback sucker are found during pre-treatment surveys or if there is reason to believe the treatment area is occupied and critical for spawning and rearing, NPS would communicate with the Service AESO prior to conducting these actions to determine whether to halt this action in this area or conduct salvage relocation. ● NPS would not implement Actions C1, C2, C3, or C4 in the same location for more than 5 consecutive years. If this action is not effective as a long-term solution when implemented over a 5-year period under the implementation of this Proposed Plan, NPS would pursue additional planning and compliance for any subsequent actions not included within this BA. ● Registered piscicide treatments (C2, C3, or C4): ○ NPS would seek state permits and follow state treatment plan requirements and guidelines. Additionally NPS would follow the NPS approval process and required pesticide use plan. Rotenone or antimycin would be applied in accordance with labels and the appropriate standard operating manuals (Finlayson et al. 2010; Moore et al. 2008). Formulations and application rates would be selected to minimize potential effects for birds and mammals and minimize toxicity to

			aquatic invertebrates. These would be used with standard neutralizing agents. ● Experimental treatments to overwhelm ecosystem cycling capabilities (C1) ○ Treatments with naturally occurring compounds (i.e., ammonia, carbon dioxide, pH alteration, or oxygen-level alteration treatments) could be used for research purposes and to control non-native invertebrate, amphibian, and fish species in targeted, small backwater or off-channel habitat areas (Ward et al. 2011; Ward 2015; Treanor et al. 2017). ○ These would be limited to small backwater areas (< 5 ac) and would be performed under appropriate state experimental permits through ADEQ or other agencies as required. ● Chemical treatments under actions C1, C2, C3, C4 would include: ○ Standard pre-treatment monitoring and watershed assessment within five days prior of application to ensure the treatment area conditions are accurately characterized and representative. This may include: Secchi depth transparency; water temperature, dissolved oxygen, and pH depth profiles; collection of non-native and native fish for use in bioassays; water flow, water quality and soil samples. ○ Barrier construction (if necessary) that could include an impermeable barrier (turbidity curtain) and/or a temporary barrier net may be installed to minimize movement of piscicide from the treatment area into the river (turbidity curtain), and to contain and facilitate removal of dead fish (turbidity curtain and/or net). ○ Native species salvage and relocation prior to piscicide treatment using boat or backpack electrofishing or netting/trapping. ○ Pre-treatment bioassay of water quality conditions would be conducted (e.g., pH, alkalinity, water temperature, sunlight exposure) as needed for adjustments to treatments. ○ Proper storage, transfer and mixing and spill response procedures will be used. ○ Fish will be actively removed during and after the treatment and any remaining fish found at the site will be removed and disposed within 48 hr of treatment at a landfill, or left in

			place if few in number, small in size, or sunken to the bottom and inaccessible to avian and terrestrial scavengers. ○ Monitoring would include the use of sentinel fish throughout the treatment area, and immediately downstream of the treatment area. CM-12. Conservation Measures for Incentivized Harvest (H1) ● NPS would make available educational information to anglers in the Glen Canyon reach in the form of signs or information for the identification of humpback chub and razorback sucker, and other native fish, and provide direction to anglers to return these species to the river. ● NPS would make available educational information to anglers in the Glen Canyon reach to discourage any potential non-native introductions. CM-13. Conservation Measures for YY Male Introductions (B1) • NPS will communicate with the Service prior to the first introduction of YY male non-native fish to determine if any new studies or modeling suggests that additional consultation is needed. Modeling for any species of YY male would be based on the spreadsheet model for brown trout YY males (Appendix B) and should include new or revised estimates for annual numbers to be stocked, survival/mortality rates, emigration rates, predation rates, and number of years to stock. • NPS will work with the Service and the Grand Canyon Monitoring and Research Center (GCMRC) prior to implementation to ensure that introduction of YY males is not expected (based on the modeling and current conditions) to cause the Tier 1 or Tier 2 triggering conditions in the LTEMP BO to be reached due to the YY males introduced (given the current status of humpback chub population, the estimated predator index in the Little Colorado River area, and the estimated number of introduced YY male migrants to reach the Little Colorado River). In addition, if the Tier 1 or Tier 2 trigger have already been reached in a given year or are modeled to be reached in the next year, regardless of the YY introductions, then NPS would not introduce YY males in that year. • Prior to introducing YY male brown trout in the mainstem, a pilot study will be conducted, either by NPS, or a comparable project completed elsewhere by another agency under their own compliance may be substituted.

			○ If NPS conducts the pilot study of brown trout YY male introduction, it will be done first on a limited basis for between 2-5 years in a GCNP tributary. Prior to the introduction, NPS will communicate and seek agreement from the Service on the specifics of the stocking level, locations and conditions. The stocking level maximum for a pilot study in GCNP would be 2,000 adult brown trout (or an equivalent number of juveniles adjusted for expected mortality) per year; however, the actual number could be lower based on communication with the Service about current conditions, and the population of brown trout in the action area at that time (e.g. 2017 population of adult brown trout in Bright Angel Creek >230 mm was 626; B. Healy pers. comm. 2018). ○ During the pilot study in GCNP, all brown trout YY males would be PIT tagged to more closely monitor migration and survival rates using existing studies in the tributary and the mainstem, and existing passive antenna arrays. • Upon conclusion of a pilot study, NPS will communicate about the results with the Service and if there is agreement that this was an applicable and successful study, then NPS may consider a YY male brown trout introduction in the mainstem. NPS may then stock an annual maximum of 5,000 adult brown trout in the Glen Canyon reach (or an equivalent number of juveniles adjusted for expected mortality). ○ After the pilot study, NPS will PIT tag every introduced YY male for the first five years to monitor migration rates. After the first five years, NPS will PIT tag a proportion of the introduced cohort sufficient to continue monitoring migration rates. In addition, NPS will mark or tag all introduced YY males to assist with identification by agencies and anglers. • YY male non-native fish stocking would be discontinued in a location or for a species if: ○ NPS determines through monitoring or in communication with the Service that the introduced YY male non-native fish are having a negative effect beyond what is estimated based on this consultation process on the humpback chub or razorback sucker populations; or

			○ If the rates of survival and migration of YY male brown trout from the stocking location to the Little Colorado River reach are greater than what was modeled; or ○ If the reproductive success of the introduced YY males is determined to be too low to be effective. Under these conditions, the NPS would cease introductions and would use mechanical removal or other available tools to remove the introduced YY male non-native fish to reduce and mitigate the threat. • NPS would communicate and seek agreement with the Service prior to implementation for any new area where YY male brown trout are being considered for introduction. • Tagging or marking of species other than brown trout would be consistent with the approach discussed above. • To enhance the effectiveness of this method, NPS would utilize incentivized harvest, mechanical removal or other efforts in conjunction with the YY-introductions to reduce the population of wild brown trout. CM-14. Conservation Measures for Other Control Actions not Covered Above (M1, M2, M3, M4, P1, P2, P3, P4, P5) ● Monitoring for unintended or unacceptable effects and tracking of non-target native or federally listed species encountered in any treatment areas. ● When applicable, prior to control treatment, boat electrofishing and/or barge or backpack electrofishing or netting/trapping will be used to survey and, as appropriate, salvage native species. Native species would be relocated live to another stretch of the same river/stream outside of the treatment area. ● For Action P5 specifically, temperatures would be heated over a period of approximately 8 hr using a propane heater powered by a generator. This would prevent causing temperature shock to the fish. Additionally, NPS would carefully monitor the main channel of the stream below the mixing point to ensure the temperature change is negligible after mixing. Continued monitoring and temperature adjustment would occur after the target temperature is reached. ● For Actions M1, M3, M4, P1, P3, P5 if any humpback chub or razorback sucker are found during pre-treatment surveys or if there is reason to believe the treatment area is occupied and critical for spawning and rearing, NPS would communicate with the Service

			prior to conducting these actions to determine whether to halt this action in this area. When practicable, NPS would avoid conducting actions in these areas during spawning season for humpback chub and razorback sucker. CM-15. Conservation Measures for Mollusk Repellents and Herbicides (C5, C6) ● Aquatic application of herbicides (Action C5) would be applied according to label and would be subject to strict guidelines and controls to protect aquatic species and water quality, including the NPS required pesticide use plan and NPS approval processes in strict adherence with applicable regulations and guidelines. Aquatic applications will only occur in backwater and off-channel aquatic habitats and tributaries. ● Mollusk repellents that contain capsaicin will be used on boats and equipment in the river, or non-toxic anti-fouling paints that do not contain copper and are approved for use in Arizona will be used. All use of repellent and anti-fouling paint would be subject to NPS pesticide use plan and approval processes in strict adherence to applicable regulations and guidelines. CM-16. Interagency Coordination: ● All sampling activities will be coordinated with AGFD (according to 43 CFR part 24) and the Service Arizona Fish and Wildlife Conservation Office and AESO, as well as the USGS-GCMRC or other agencies performing fish monitoring or research within the project-area. ● Annual reports documenting implementation and monitoring conducted by the NPS will be provided to the Service, AGFD, Reclamation, USGS and other interested parties. ● Bi-monthly, or more frequently as needed, conference calls (or written status updates in lieu of a call) will continue to be held by the NPS Fisheries Program to update interested parties on ongoing or new NPS management activities under the Proposed Action. ● In the selection of an herbicide (Action C5), NPS will consider (1) the site location to be treated, (2) the non-native vegetation, and (3) the time of year and water temperatures. Herbicide selection will be communicated with the Service and Arizona for a NPDES prior to the initiation of the action. ● If the NPS planned to introduce YY males of species other than brown trout, or in locations other than Glen Canyon reach, or stocking

			numbers other than those specified in the Proposed Plan were being contemplated, the NPS would communicate and seek agreement with the Service prior to initiation of the action. Also, if prior to the availability of brood stock for YY male brown trout, new modeling or studies become available for brown trout YY males that suggest potentially different mortality/survivorship or migration values or other significant parameters, then NPS would reassess and communicate or consult with the Service as needed. If new information becomes available regarding non-native movement rates and/or predation rates, the model will be re-evaluated to ensure the anticipated impacts of this action on humpback chub or razorback suckers are not greater than anticipated in the current analyses.
P.D-3 L.27	Zuni - APPENDIX D - ALTERNATIVES AND CONTROL ACTIONS CONSIDERED BUT DISMISSED FROM DETAILED ANALYSIS - D.4 CONCUSSIVE CONTROL USING DETONATION CORD	Detonation cord has been used for fishery management in many locations. Preliminary analysis indicated concerns with using this tool in this location because of safety issues during transport and handling and the need for specialized handling permits. In addition, this method would only work in deeper water (>5 ft) so few, if any off-channel areas would meet this criteria. It would also have impacts to non-target species if used in backwater or riverine systems. Compared to other control actions, the use of detonation cord has a number of potential disadvantages including damage or destruction of benthic habitats, safety issues, and public perception. The use of sonic concussive devices may have less deleterious effects on habitats, and was retained in the Proposed Action. NPS dismissed inclusion of detonation cord from further consideration as it was duplicative of other less environmentally damaging or less expensive alternatives.	Detonation cord has been used for fishery management in many locations. Preliminary analysis indicated concerns with using this tool in this location because of safety issues during transport and handling and the need for specialized handling permits. In addition, this method would only work in deeper water (>5 ft) so few, if any off-channel areas would meet this criteria. It would also have impacts to non-target species if used in backwater or riverine systems. Compared to other control actions, the use of detonation cord has a number of potential disadvantages including damage or destruction of benthic habitats, safety issues, and public perception. The use of acoustic fish deterrent and guidance devices would have less deleterious effects on habitats, and was retained in the Proposed Action. NPS dismissed inclusion of detonation cord from further consideration as it was duplicative of other less environmentally damaging or less expensive alternatives.
P.D-3 L.45	Zuni sonic concussive concerns - APPENDIX D - ALTERNATIVES AND CONTROL ACTIONS CONSIDERED BUT DISMISSED FROM DETAILED ANALYSIS		D.6 SONIC CONCUSSIVE DEVICES Sonic concussive devices, using pulse pressure from seismic water guns, have been used experimentally as a non-native fish management tool. Gross et al (2013) found that about 96% of northern pike exposed to pulsed pressure waves in a field experiment had tissue damage that was likely to be fatal and that 31% had died within 7 days after exposure. This action was analyzed in the EA, however, NPS decided to drop this option from the Proposed Action based on comments from the Pueblo of Zuni tribe that this tool was particularly offensive to their taking of aquatic life concerns about aquatic species, due to length of time for mortality.
P.F-3	NPS internal consistency correction –	Present in GCNP, exact locations unspecified (NPS 2018b; NPS 2015)	Present in GCNP, exact locations unspecified (NPS 2018b; NPS 2015a)

	Table F-1 row Yellow bullhead, column: Location Documentation.		
P.F-8	Hopi comments regarding trout management differences – Table F-1, footnote d	Rainbow trout is in a special category because NPS manages this species for a quality recreational rainbow trout fishery in GCNRA, but in GCNP, rainbow trout are controlled as an undesirable non-native fish to reduce impacts to native species, consistent with goals and objectives of the CFMP. No control actions under the Proposed Action in this EA would be applied to target rainbow trout in GCNRA, but any of the control options for any threat levels under the Proposed Action may be applied to rainbow trout in GCNP.	Rainbow trout is in a special category because NPS manages this species for a quality recreational rainbow trout fishery in GCNRA, but in GCNP, rainbow trout are controlled as an undesirable non-native fish to reduce impacts to native species, consistent with goals and objectives of the CFMP. No control actions under the Proposed Action in this EA would be applied to target rainbow trout in GCNRA, but any of the control options for any threat levels under the Proposed Action may be applied to rainbow trout in GCNP. In the CFMP they are considered a higher level of threat in Grand Canyon National Park.
P.J-1	Zuni – Appendix J, References	Ainslie, B.J., J.R. Post and A.J. Paul, 1998, "Effects of Pulsed and Continuous DC Electrofishing on Juvenile Rainbow Trout." North American Journal of Fisheries Management 18: 905-918.	*(Deleted)*
P.J-2	UCRC and IEDA – Appendix J, References		Ault, T.R, J. S. Mankin, B. I. Cook, J. E. Smerdon, 2016. Relative impacts of mitigation, temperature, and precipitation on 21st-century megadrought risk in the American Southwest. Sci. Adv. 2, e1600873.
P.J-2	Anglers – Appendix J, References		Avery, L.A., J. Korman, and W.R. Persons, 2015, "Effects of Increased Discharge on Spawning and Age-0 Recruitment of Rainbow Trout in the Colorado River at Lees Ferry, Arizona," North American Journal of Fisheries Management, 35: 671-680, DOI: 10.1080/02755947.2015.1040560.
P.J-3	Anglers – Appendix J, References		Bonvechio, T.F., M.S. Allen, D. Gwinn, and J.S. Mitchell, 2011, "Impacts of Electrofishing Removals on the Introduced Flathead Channel Catfish Population in the Satilla River, Georgia," Pages 395–407 in P.H. Michaeltez and V.H. Travnichek, editors, Conservation, Ecology, and Management of Channel Catfish: the Second International Symposium, American Fisheries Society, Symposium 77, Bethesda, Maryland.
P. J-3	Anglers - References		Boyer, J.K. and D.L. Rogowski. (*in press)*. Status of the Lees Ferry Rainbow Trout Fishery 2018 Annual Report. Arizona Game and Fish Department. Submitted to: Grand Canyon Monitoring and Research Center - USGS, Flagstaff, AZ.
P.J-3	Anglers – Appendix J, References		Coggins, L.G., Jr., 2008, Active Adaptive Management for Native Fish Management in the Grand Canyon—Implementation and Evaluation: Gainesville, University of Florida, Ph.D. dissertation, 173 p.
P.J-3	Anglers		Coggins, L.G., Jr., and Yard, M.D., 2010, Mechanical Removal of Non-Native Fish in the Colorado River within Grand Canyon, in Melis, T.S.,

	– Appendix J, References		Hamill, J.F., Coggins, L.G., Bennett, G.E., Grams, P.E., Kennedy, T.A., Kubly, D.M., and Ralston, B.E., eds., Proceedings of the Colorado River Basin Science and Resource Management Symposium, November 18–20, 2008, Scottsdale, Arizona: U.S. Geological Survey Scientific Investigations Report 2010–5135, p. 227–234.
P.J-7	Sierra club and anglers – Appendix J, References		Kennedy, T.A., 2007, A Dreissena Risk Assessment for the Colorado River Ecosystem. U.S. Geological Survey Open-File Report 2007-1085, 24 pp. Available at http://pubs.usgs.gov/of/2007/1085/. Accessed November 5, 2018.
P.J-8	NPS internal consistency reference correction – Appendix J, References	Korman, J., M.D. Yard, and C.B. Yackulic, 2015. "Factors Controlling the Abundance of Rainbow Trout in the Colorado River in Grand Canyon in a Reach Utilized by Endangered Humpback Chub," Canadian Journal of Fisheries and Aquatic Sciences, 73(1): 105–124, http://dx.doi.org/10.1139/cjfas-2015-0101.	Korman, J., M.D. Yard, and C.B. Yackulic, 2016. "Factors Controlling the Abundance of Rainbow Trout in the Colorado River in Grand Canyon in a Reach Utilized by Endangered Humpback Chub," Canadian Journal of Fisheries and Aquatic Sciences, 73(1): 105–124, http://dx.doi.org/10.1139/cjfas-2015-0101.
P.J-8	UCRC and IEDA – Appendix J, References		McCabe, G.J., D.M. Wolock, G.T. Pederson, C.A. Woodhouse, S. McAfee. 2017. "Evidence that Recent Warming is Reducing Upper Colorado River Flows." *Earth Interactions*, 21(10) pp. 1-14.
P.J-8	UCRC and IEDA – Appendix J, References		Melillo, J. M., T.C. Richmond, G. W. Yohe, Eds., 2014. *Climate Change Impacts in the United States: The Third National Climate Assessment*. U.S. Global Change Research Program, 841 pp. doi:10.7930/J0Z31WJ2.
P.J-9	UCRC and IEDA – Appendix J, References		Mote, P.W., S. Li , D.P. Lettenmaier, M. Xiao, R. Engel, 2018. "Dramatic Declines in Snowpack in the Western US." *Climate and Atmospheric Science* (2018) 1:2 ; doi:10.1038/s41612-018-0012-1
P.J-9	UCRC and IEDA – Appendix J, References		National Research Council, 2007, *Colorado River Basin Water Management: Evaluating and Adjusting to Hydroclimatic Variability*. Washington, DC: The National Academies Press. https://doi.org/10.17226/11857.
P.J-9	Anglers – Appendix J, References		Noatch, M.R., and C.D. Suski, 2012, "Non-Physical Barriers to Deter Fish Movements." *Environmental Reviews* 20:1-12.
P.J-9	NPS Internal consistency correction – Appendix J, References		NPS, 2015b. Brown Trout. Available at. https://www.nps.gov/shen/learn/nature/brown-trout.htm. Accessed October 2018.
P.J-10	Anglers – Appendix J, References		Propst, D.L., K.B. Gido, J.E. Whitney, E.I. Gilbert, T.J. Pilger, A.M. Monié, Y.M. Paroz, J.M. Wick, J.A. Monzingo, and D.M. Myers, 2014, "Efficacy of Mechanically Removing Nonnative Predators from a Desert Stream," River Research and Applications 31:692-703.
P.J-10	UCRC and IEDA – Appendix J, References		Reclamation, 2012a, *Colorado River Basin Water Supply and Demand Study: Executive Summary*. U.S. Department of the Interior, Bureau of

			Reclamation, 28 pp., https://www.usbr. gov/watersmart//bsp/docs/ finalreport/ColoradoRiver/CRBS_Executive_Summary_FINAL.pdf.
P.J-15	UCRC and IEDA – Appendix J, References		Udall, B., and J. Overpeck, 2017, "The Twenty-First Century Colorado River Hot Drought and Implications for the Future." *Water Resources Research*, 53, 2404–2418, https://doi.org/10.1002/ 2016WR019638.
P.J-15	Zuni – Appendix J, References		USACE (U.S. Army Corps of Engineers), 2013, Acoustic Fish Deterrents, Available at http://glmris.anl.gov/documents/docs/ anscontrol/AcousticFishDeterrents.pdf. Accessed November 14, 2018.
P.J-15	UCRC and IEDA – Appendix J, References		Vano, J.A., T. Das, D.P. Lettenmaier, 2012, "Hydrologic Sensitivities of Colorado River Runoff to Changes in Precipitation and Temperature." *Journal of Hydrometerorology*, Volume 13. Pp. 932-949.
P.J-15	Zuni – Appendix J, References		Vetter, B.J., K.A. Murchy, A.R. Cupp, J.J. Amberg, M.P. Gaikowski, and A.F. Mensinger, 2016, "Acoustic Deterrence of Bighead Carp (*Hypophthalmichthys nobilis*) to a Broadband Sound Stimulus." *Journal of Great Lakes Research*, 43:163-171.
P.J-16	UCRC and IEDA – Appendix J, References		Woodhouse, C. A., G. T. Pederson, K. Morino, S. A. McAfee, and G. J. McCabe, 2016, "Increasing Influence Of Air Temperature on Upper Colorado River Streamflow." *Geophysical Research Letters*, 43, 2174–2181, https://doi.org/10.1002/2015GL067613.
P.J-16	UCRC and IEDA – Appendix J, References		Xiao, M., B. Udall. D.P. Lettenmaier, 2018, "On the Causes of Declining Colorado River Streamflows." *Water Resources Research*. 54(9). pp. 6739-6756. https://doi.org/10.1029/2018WR023153.

ATTACHMENT C: NON-IMPAIRMENT DETERMINATION

NON-IMPAIRMENT DETERMINATION

FOR THE EXPANDED NON-NATIVE AQUATIC SPECIES MANAGEMENT PLAN IN GLEN CANYON NATIONAL RECREATION AREA AND GRAND CANYON NATIONAL PARK BELOW GLEN CANYON DAM ENVIRONMENTAL ASSESSMENT

National Park Service
Region Serving DOI Regions 5, 6, 7, 8, 9
Glen Canyon National Recreation Area
Grand Canyon National Park

September 2019

The National Park Service (NPS) is required by the *Management Policies 2006* (Section 1.4) to make a written determination regarding whether or not an NPS action would impair a park's resources and values. This non-impairment determination has been prepared for the Selected Action for the Expanded Non-Native Aquatic Species Management Plan in Glen Canyon National Recreation Area and Grand Canyon National Park Below the Glen Canyon Dam, Proposed Alternative, as described in the Finding of No Significant Impact (FONSI).

By enacting the NPS Organic Act of 1916 (Organic Act), Congress directed the U.S. Department of the Interior and the NPS to manage units "to conserve the scenery, natural and historic objects, and wild life in the System units and to provide for the enjoyment of the scenery, natural and historic objects, and wild life in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (54 U.S.C. 100101).

NPS *Management Policies 2006* (NPS 2006), Section 1.4.4, explains the prohibition on impairment of park resources and values:

> "While Congress has given the Service the management discretion to allow impacts within parks, that discretion is limited by the statutory requirement (generally enforceable by the federal courts) that the Park Service must leave park resources and values unimpaired unless a particular law directly and specifically provides otherwise. This, the cornerstone of the Organic Act, establishes the primary responsibility of the National Park Service. It ensures that park resources and values will continue to exist in a condition that will allow the American people to have present and future opportunities for enjoyment of them."

The NPS has discretion to allow impacts on park resources and values when necessary and appropriate to fulfill the purposes of a park (NPS 2006, Section 1.4.3). However, the NPS cannot allow an adverse impact that will constitute impairment of the affected resources and values (NPS 2006, Section 1.4.3). An action constitutes impairment when its impacts "harm the integrity of park resources or values, including the opportunities that otherwise will be present for the enjoyment of those resources or values" (NPS 2006, Section 1.4.5). To determine impairment, the NPS must evaluate the "particular resources and values that will be affected; the severity, duration, and timing of the impact; the direct and indirect effects of the impact; and the cumulative effects of the impact in question and other impacts: (NPS 2006, Section 1.4.5).

As stated in NPS *Management Policies 2006* (NPS 2006, Section 1.4.5), an impact on any park resource or value may constitute an impairment, but an impact would be more likely to constitute an impairment to the extent that it affects a resource or value whose conservation is:

- Necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park; or
- Key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or
- Identified in the park's general management plan or other relevant NPS planning documents as being of significance.

The purpose and significance of both Glen Canyon National Recreation Area (GCNRA) and Grand Canyon National Park (GCNP) were considered during this impairment determination process for the Selected Action. GCNRA was established:

> "to provide for public outdoor recreation use and enjoyment of Lake Powell and lands adjacent thereto in the States of Arizona and Utah and to preserve scenic, scientific, and historic features contributing to public enjoyment of the area."

GCNP was established to:

> *"*provide for the recognition by Congress that the entire Grand Canyon, from the mouth of the Paria River to the Grand Wash Cliffs, including tributary side canyons and surrounding plateaus, is a natural feature of national and international significance."

Statements of a park's significance describe why a park is important within a global, national, regional, and ecosystem-wide context and are directly linked to the purpose of the park. For GCNP, additional significance is found in the 1979 World Heritage designation, which states "The Grand Canyon is among the earth's greatest ongoing geological spectacles. Its vastness is stunning; the evidence it reveals about the earth's history invaluable. The 1.5-kilometer (0.9 mile)-deep gorge ranges in width from 500 m to 30 km (0.3 mile to 18.6 miles). The Canyon twists and turns 445 km (276.5 miles), and was formed during six million years of geologic activity and erosion by the Colorado River on the earth's upraised crust. The Canyon's buttes, spires, mesas, and temples appear as mountains when viewed from the rims. Horizontal strata exposed in the canyon retrace geological history over two billion years and represent the four major geologic eras."

GCNP is significant for the following reasons:

- It one of the planet's most iconic geologic landscapes.

- During the last six million years, the Colorado River carved Grand Canyon; these same erosional and tectonic processes continually shape the canyon today. The Grand Canyon's exposed layers span more than one-third of the Earth's history and record tectonic and depositional environments ranging from mountain-building to quiet seas. Taken as a whole, the Grand Canyon, with its immense size, dramatic and colorful geologic record exposures, and complex geologic history, is one of our most scenic and scientifically valued landscapes.

- The force and flow of the Colorado River, along with its numerous and remarkably unaltered tributaries, springs, and seeps, provide plants and animals opportunity to flourish in this otherwise arid environment. These vital resources represent transmission of local aquatic recharge from high-elevation rims to the arid inner canyon. There are hundreds of known seeps and springs throughout the park, and probably more to be discovered.

- Wilderness landscapes are an important current resource and future preserve. Park boundaries extend beyond canyon walls to include 1,904 square miles (1,218,376 acres) of which 94% are managed as wilderness. When combined with additional contiguous public and tribal lands, this area makes up one of the largest U.S. undeveloped areas. The Grand Canyon offers outstanding opportunities for visitor experiences, including extended solitude, natural quiet, clean air, dark skies, and a sense of freedom from the mechanized world's rigors.

- GCNP contains a superlative array of natural resources. Much of this diversity can be attributed to the park's dramatic topographic spectrum. This elevational variety provides microhabitats for natural processes supporting rare and endemic plant and wildlife species. These diverse habitats serve as a living laboratory for scientific research in numerous fields that contribute greatly to our understanding of the relationship between biotic communities and abiotic environments.

- The human-Grand Canyon relationship has existed for at least 12,000 years. The Canyon is an important homeland for native people and a place of historic Euro-American exploration and discovery. Today that relationship continues; both for ongoing Native American associations and millions of visitors who visit the canyon and its surrounding landscapes.

- The Grand Canyon's immense and richly colored scenic vistas, enhanced by a natural setting, inspire a variety of emotional, intellectual, artistic, and spiritual impressions. Its unsurpassed natural beauty is a source of profound inspiration for people worldwide.

The purpose statement of GCNP further articulates the preservation mandate by stating that the mission is to preserve and protect the Grand Canyon's unique geologic, paleontologic, and other natural and cultural features for the benefit and enjoyment of the visiting public; provide the public opportunity to experience the Grand Canyon's outstanding natural and cultural features, including natural quiet and exceptional scenic vistas; and protect and interpret the Grand Canyon's extraordinary scientific and natural values.

Similarly, GCNRA, located at the center of the Colorado Plateau, provides for public enjoyment through diverse land- and water-based recreational opportunities, and protects scenic, scientific, natural, and cultural resources on Lake Powell, the Colorado River and its tributaries, and surrounding lands.

GCNRA is significant for the following reasons:

- The Colorado River and its many tributaries, including the Dirty Devil, Paria, Escalante, and San Juan Rivers, carve through the Colorado Plateau to form a landscape of dynamic and complex desert and water environments.

- The vast, rugged landscapes of GCNRA provide an unparalleled spectrum of diverse land- and water-based recreational opportunities for visitors of wide-ranging interests and abilities.

- GCNRA preserves a record of more than 10,000 years of human presence, adaptation, and exploration. This place remains significant for many descendant communities, providing opportunities for people to connect with cultural values and associations that are both ancient and contemporary.

- The deep, 15-mile-long, narrow gorge below the dam provides a glimpse of the high canyon walls, ancient rock art, and a vestige of the riparian and beach terrace environments that were seen by John Wesley Powell's Colorado River expedition in 1869, providing a stark contrast to the impounded canyons of Lake Powell.

For the Selected Action, a determination of non-impairment is made for each of the resources carried forward for detailed analysis in the Environmental Assessment (EA). Pursuant to the Guidance for Non-Impairment Determinations and the NPS NEPA Process (NPS 2011), impairment findings are not necessary for visitor experience, socioeconomics, public health and safety, environmental justice, land use, or park operations, because these impact topics are not generally considered to be park resources or values in this context and are therefore not subject to the written impairment determination requirement found in NPS *Management Policies 2006*. A description of the current state of each of the resource topics evaluated for impairment can be found in Chapter 3 of the EA, "Affected Environment". Those resources carried forward for which a non-impairment determination has been completed include water resources, aquatic resources, vegetation, wildlife, and cultural resources.

Water Resources

The Colorado River and its tributaries, the reservoirs of Lake Powell and Lake Mead, and the seeps and springs on NPS-managed lands are significant water resources within GCNP, GCNRA and Lake Mead National Recreation Area (LMNRA). The Glen Canyon Dam controls the flow of the Colorado River through both park units and affects the reservoir levels in Lake Powell and Lake Mead, but the Selected Action will not change the operations of the Glen Canyon Dam, so the effects on water resources would be primarily to water quality. The direct effects to water quality as they relate to impairment are addressed in full in this section. Water quality can also affect a number of other resources including aquatic resources and wildlife which are addressed separately below.

Proposed control actions could affect water quality in several ways. Actions that involve sediment disturbance (mechanical disruption of spawning areas, Action M1; mechanical harvesting of plants and algae, Action M4), dredging (dredging to reconnect the Upper and Lower Sloughs, Action P4), or excavating (placement of weirs or barriers, Actions P2 and P3) would produce localized turbidity plumes in the immediate area and downstream of the actions. Such plumes would be episodic, localized, and occur during the action itself and potentially continuing for a few days afterward. These actions would not increase overall turbidity conditions in receiving waters, as many of these areas are normally quite turbid especially in areas downstream of the slough, during HFEs, or following natural storms.

Warming the water to >29ºC (84ºF) for coldwater species control in tributaries (Action P5) would produce temperature increases in treated areas (up to a 1,500-ft-long stream segment), but the effect is likely to be beneficial to native species that evolved with warmer waters, and would be limited to that segment and decrease in a downstream direction due to dilution and limited to a maximum of 6 weeks. No effect in areas upstream of treatment areas would be expected, and any residual warmer water entering the main channel Colorado River would be quickly dispersed. Overall, these turbidity and temperature effects are very small and localized, resulting in very limited effects.

Application of chemical controls, including use of piscicides (Actions C2 and C3), herbicides (Action C5), other chemical treatments (Action C1), and mollusk repellents on boats and other surfaces (Action C6) has the potential to affect water quality outside of application areas if these chemicals are transported through flow or diffusion out of the target treatment area. Piscicides, such as antimycin and rotenone, would be applied in strict adherence to applicable regulations and guidelines, including: NPS approval processes, AGFD's Piscicide Treatment Planning and Procedures Manual (AGFD 2012), and FWS's Rotenone SOP Manual (Finlayson et al. 2018), which would limit or eliminate the potential for effects outside of the target treatment area, and any incidental lethal or sublethal effects on non-target aquatic species and habitats. In addition, use of piscicides would require an approved Arizona Pollutant Discharge Elimination System permit under the Clean Water Act as administered by the state of Arizona. Following these regulations and guidelines would minimize downstream effects of piscicide applications by ensuring that appropriate treatment quantities are used and treatments are confined to target areas. Aquatic application of herbicides would likewise be subject to strict guidelines and controls to protect aquatic species and water quality, including NPS approval processes in strict adherence with applicable regulations and guidelines. Herbicide formulations include inerts, surfactants, and adjuvants, which would be released to water bodies in aquatic applications. Neither the active herbicide nor these additives would have adverse effects on non-target organisms or water quality when used as directed by the manufacturer, and with strict adherence to applicable regulations and guidelines. The use of chemicals would be spatially and temporally limited. Additionally, chemicals would only be used if other methods were ineffective and there was a need to protect other resources from the impacts of higher risk non-native species.

Mollusk repellents for use on boats and equipment used in the river contain capsaicin, an irritant and the hot spice found in chili peppers. Current products incorporate capsaicin in a wax base, which minimizes its release into water and the potential for impacts on non-target organisms, but could require re-application on an annual basis. EPA notes in its pesticide reregistration summary for capsaicin that the agency relies on restrictive product label statements to minimize exposures and reduce any risks to aquatic species (EPA 1992). In addition, only non-toxic anti-fouling paints that do not contain copper and are approved for use in Arizona would be used for mollusk control. All use of repellent and anti-fouling paint would be subject to NPS approval processes in strict adherence to applicable regulations and guidelines.

Chemical treatments to overwhelm natural cycling processes in small backwaters and off-channel areas for control of non-native aquatic species, by their nature, would temporarily affect the water quality of the treated waters. Such treatments would use natural occurring substances, but purposely change water quality parameter values outside of their natural range to create conditions unsuitable to targeted aquatic life. Treatments could include altering pH using ammonia or carbon dioxide, or altering oxygen levels. Such treatments would require confined water bodies to reach desired conditions, and thus would have limited potential for effects outside of the target area. Any treated water moving downstream would quickly dilute to within natural levels and thus would have very short range and temporary effects likely resulting in the avoidance of the area by mobile species, and no or very low incidental mortality in non-target species. Reversing treatments and natural attenuation would quickly return affected areas to natural conditions. These very limited chemical tests would be constrained to small areas that were surveyed for native species prior to implementation. Therefore, there would be very few effects to non-target species..

In summary, the Selected Action will only have direct and indirect effects that are of limited severity, duration, and timing; and will have no long-term or cumulative negative impacts on water availability or water quality. The integrity of these water resources will not be harmed, and these resources will continue to exist in a manner that can be enjoyed by current and future generations. Therefore, water resources will not be impaired by implementing the Selected Action.

Aquatic Resources

All control measures under the Proposed Action would provide some level of suppression of non-native aquatic species. Some of the control actions, particularly incentivized harvest, mechanical removal (electrofishing) of brown trout in the Glen Canyon reach, and experimental stocking of YY-male fish to minimize reproductive success, would undertake larger-scale and potentially longer-term control actions to maximize system-wide control.

Incentivized Harvest (Action H1; Tier 1)

Incentivized harvest is intended to increase angling activities and removal for targeted species. It is anticipated that brown trout would be the initial focus of any incentives to increase angler harvest. Other high-risk species within specific areas, including walleye and smallmouth bass, could also be targeted. There are currently no harvest limits on brown trout in the project area. The potential for benefits to native aquatic species due to implementation of incentivized harvest awards and programs would ultimately depend on its effectiveness for suppressing populations of non-native fishes. There is evidence that reducing the abundance of non-native species from specific habitat areas can result in improvements in survival and recruitment of native fishes (Healy et al. 2018). In addition, Runge et al. (2018) modeled the potential for incentivized harvest of brown trout in the Glen Canyon reach to affect humpback chub populations in downstream reaches and concluded that incentivized harvest of brown trout could slightly increase the median minimum abundance of adult humpback chub compared to the status quo (i.e., no additional brown trout control, similar to the No-Action Alternative). Based on modeling, Runge et al. (2018) also concluded that increasing removal of brown trout through incentivized harvest would have only small effects on the median abundance

of rainbow trout compared to the status quo condition. Overall, using incentivized harvest to remove brown trout would have negligible effects on the population of rainbow trout or the condition of the rainbow trout fishery in Glen Canyon. Also the effects of physical impacts to aquatic resources from increased angling would be expected to be negligible compared to current conditions because changes are likely to be within the range of conditions observed during annual peak flow and base flow cycles that mobilize and deposit sediments disturbed by anglers.

Dewatering with Pumps (Action P1; Tier 1)

Under this action, a small number of off-channel ponds and backwaters throughout the project area, each up to 0.5 acre in size, could be affected by dewatering during specific years. Dewatering would be for a maximum of 2 weeks. Even if this control option was applied to multiple ponds or backwaters within a given year, the total amount of habitat disturbed within a specific year would be small (e.g., less than 5 acres if applied at 10 locations) relative to the amount of similar habitat available in the project area. This tool would be used to target non-native species but could impact some native aquatic individuals. However surveys would be conducted prior to the dewatering treatment and native species found during these surveys would be relocated, so any mortality of non-target native species would be such a small number as to not impact the overall native populations of these species.

Placement of Weirs or Barriers (Actions P2, P3; Tier 1)

This control action could be used at any suitable tributary, backwater, or pond habitat within the project area, including the RM -12 sloughs, when the presence of high-risk non-native aquatic species are detected. Installation of weirs and barriers would result in a small amount of habitat disturbance on the adjacent shoreline and streambed and some increase in turbidity during the installation process. In most cases, structures would be in place for one or more seasons and then be removed, although structures for supporting some weirs may be designed to remain in place for many years. Barriers used to prevent ingress of non-native fishes into specific habitat areas could enhance survival and recruitment of native fishes in tributaries, backwaters, and shoreline ponds by reducing predation and competition. For weirs that are associated with fish traps, such as the weir used at Bright Angel Creek (Healy et al. 2018), there would be little potential for incidental mortality of native species because most individuals would be released on the other side of the weir while non-native fishes would be removed. For barriers that are only used for short periods (e.g., for a few hours while seining or electrofishing in backwaters) the effect of movement restrictions on native fishes would be negligible. If appropriate, disturbed habitat locations would be restored when barriers are removed. The amount of habitat disturbed by the installation or footprint of weirs or other barriers would be small and is expected to be no more than a few hundred square feet. Impacts to native species from changes in physical habitat conditions or water quality (Section 3.2.2) would likely be temporary during the installation process, which could last up to 5 days. Overall, the numbers of native fish or rainbow trout potentially affected by this control action would represent only a very small proportion of the overall populations.

Dredging to Connect the Upper Slough to the Lower Slough at RM -12 (Action P4; Tier 4)

This option is a more permanent alteration of the Upper Slough compared to periodic dewatering using pumps. The disturbance area would be small (it is within a 0.5 acre area) and while there would be a potential for habitat disturbance from barging equipment, fuel, and personnel and disturbance of substrate supporting benthic habitats and increased turbidity in the immediate project area during the dredging period, the construction would only be expected to take up to two weeks with recovery of conditions within 10-30 days. Algae and benthic organisms displaced during dredging would likely recolonize affected areas within weeks to months, depending on season.

NPS would conduct surveys to evaluate the types, sizes, and abundance of species present in the Upper Slough and, if practical, would remove these fish (using nets or other mechanical means), release native species to adjacent waters, and arrange for beneficial uses prior to dewatering. It is anticipated that this action would be highly effective for eliminating and controlling non-native aquatic species in the Upper Slough. Periodic maintenance dredging and/or dewatering of the Upper Slough may be needed, especially after HFEs or other high-flow events, if there is sediment deposition and/or reinvasion by non-native species.

This tool would be used to target non-native species but could impact some native aquatic individuals. However surveys would be conducted prior to the dewatering treatment and native species found during these surveys would be relocated, so any mortality of non-target native species would be so low as to not impact the overall native populations of these species.

Produce Small Scale Temperature Changes to Adversely Affect Coldwater Non-Native Fishes (Action P5; Experimental)

This control action could result in the physical disturbance of a small area (likely less than a few hundred square feet) of shoreline and streambed where heating equipment would be placed. The length of stream that could be warmed to target temperatures is expected to be at most about 1,500 ft (457 m). Depending upon the design of experiments, water temperature in the treated stream segment could be altered for one or more seasons within a given year for a maximum of 6 weeks in a given season. Should this small-scale pilot experiment prove successful at eliminating trout (without harming native fishes and invertebrates), and if heating a larger volume of water is deemed feasible, it could be expanded to treat larger sections of tributaries.

Adverse effects, such as mortality or avoidance of the area, on some warmwater native fish species could occur if water quality parameters, including DO, which decreases as water temperature increases, were to fall outside suitable biological ranges; appropriate experimental planning and monitoring would allow the potential for negative effects to be identified and managed. Once the experimental manipulation of temperature stops, water temperature and quality would quickly return to pre-treatment levels (within hours for temperature and days for other water quality parameters). Given the limited temporal and spatial scope of the experimental treatment, impacts on native aquatic species would be localized and occur only during the treatment.

This tool would be used to target non-native species but could impact some native aquatic individuals. However surveys would be conducted prior to the dewatering treatment and native species found during these surveys would be relocated, so any mortality of non-target native species would be such a small number as to not impact the overall native populations of these species. are observed

Mechanical Disruption of Early Life Stage Habitats (Action M1; Tier 2)

Mechanical disruption of spawning substrates by flushing with high-pressure water, mechanical displacement of gravel, or placement of temporary electrical grids or substrate covers (primarily from November 1 through February 28 for brown trout) would result in localized disturbance of aquatic habitat. Potential adverse impacts on spawning native fish and rainbow trout later in the year would be reduced because gravels would be returned to their place of origin during the treatment. Substrate disturbance would be less if electrical grids or substrate covers were used. Algae and benthic organisms displaced during treatments would likely recolonize affected areas within days to months after the treatment has been completed, depending upon the season of the year.

The potential for benefits to native aquatic species would depend upon the effectiveness of the control action for suppressing populations of non-native fishes. Mechanical disruption of substrate could also harm individuals or eggs of non-target species, including native species or rainbow trout, which may be present in treated habitats. This would be an experimental action designed in cooperation and consultation

with GCMRC and AGFD, and NPS would seek their partnership for implementation of this action. NPS would work with other agencies to ensure monitoring of the target non-natives (such as brown trout). This may involve various types of tagging, telemetry or otherwise monitored effectively to map out spawning areas prior to using this action. In addition, because this is an experimental action, NPS may conduct one or several smaller pilot efforts before conducting a large implementation. This action would only occur in limited stretches of tributaries, and the experiment would be stopped if unanticipated impacts to natives are observed.

Mechanical Removal (Action M2; Tiers 1, 2, or 3)

This action could consist of electrofishing or the use of nets or traps. These methods would target non-natives and generally very effective and selective methods with low mortality rates for non-target species. Boat electrofishing would generally not directly disturb aquatic habitats and use of backpack electrofishing units would result in a limited amount of habitat disturbance by wading field crews. Deployment and retrieval of static nets and traps could result in a small amount of bottom disturbance in the footprint of the net or trap itself; larger areas could be affected by crews pulling seines in some habitats. Water quality changes in the immediate area of the action would result from disturbance and suspension of fine sediments, but effects would dissipate within a few hours or days after the action was complete. In low-velocity habitats (e.g. backwaters or ponds), suspended sediments would settle and water quality would recover within several hours after cessation of harvest activities. In flowing tributaries or the mainstem, sediment suspended by disturbance would be rapidly transported from the affected area and a pulse of elevated sediment would travel through downstream areas until it settles out or is diluted or dissipated by currents. These temporary changes in water conditions would likely fall within the range of conditions experienced by aquatic organisms within the project area during an annual cycle; it is anticipated that native aquatic organisms are adapted to such changes although they may respond by temporarily avoiding affected areas.

Any non-native aquatic species in mainstem, tributaries, backwaters, or off-channel ponds within the project area could be targeted for mechanical removal using a wide variety of capture methods (Zale et al. 2012). In most cases, it is anticipated that this control action would be applied to address small, localized concentrations of non-native species in discrete habitat areas such as small tributaries, backwaters, or off-channel ponds. However, as described in Sections 2.2.2.2 and 2.2.3.1 of the EA, more extensive mechanical removal efforts could be applied as a long-term control measure if the population of brown trout in the Glen Canyon reach increased to trigger levels; however, this would be generally performed between November 1 and February 28 when brown trout could be effectively targeted with less impacts to non-target species.

Overall, the effects to native species should be minimized with electrofishing settings and selectivity, the timing of extended operations to avoid impacts to other species, and the action would be stopped if unanticipated impacts to non-target species are observed.

Use of Acoustic fish deterrent and guidance Devices (Action M3; Tier 4)

Acoustic fish deterrent and guidance devices are designed to repel fish from target areas and guide them elsewhere. This tool would be deployed to repel non-native fish from suitable breeding habitat, such as warmwater natives from warm backwater habitats where they could reproduce. Acoustic fish deterrent and guidance devices are intended to be non-lethal tools and any incidental mortality should be very low (USACE 2013). Acoustic fish deterrent and guidance devices may also repel non-target fish or amphibians and prevent their use of target areas, however the use of acoustic fish deterrent and guidance would be limited to small backwaters or ponds < 5 ac. These devices may also require some limited disturbance at the shoreline for installation of generators or solar panels to power the devices.

Mechanical Harvesting of Non-Native Plants and Algae (Action M4; Tier 1)

Some of the removal activities that could be applied under this control action, such as use of rakes, hooks, hand tools, boat rakes, and underwater weed cutters, have a potential to physically disturb some substrate by scraping and moving gravel and cobble. Overall, the spatial extent of disturbance would be limited to specific treatment areas (e.g., individual backwaters or tributary segments) and composition of the substrate would remain similar to pre-harvest conditions. There could be water quality changes due to disturbance and suspension of fine sediments during harvesting actions, but these actions and associated effects are not expected to last for more than a few days and would be mostly limited to the immediate area with effects diminishing quickly downstream. In low-velocity habitats (e.g. backwaters or ponds), suspended sediments would settle and water quality would recover within several hours after cessation of harvest activities. In flowing tributaries, sediment suspended by disturbance would be transported from the affected area and a pulse of elevated suspended sediment would travel downstream until the sediment settled out or was dissipated by currents. These temporary changes in water conditions would likely fall within the range of conditions experienced by aquatic organisms within the project area during an annual cycle; native species are adapted to such changes although they may respond by temporarily avoiding affected areas. Removal of non-native plants and algae could result in short-term reductions in overall productivity of the food base and availability of structural refuges for some aquatic organisms. Overall, habitat impacts would be unlikely to persist for more than a single season and would be localized to the vicinity of the treated areas. Mechanical harvesting of dense patches of aquatic plants has the potential to harm some non-target species, including native fish species or rainbow trout that may be using the vegetation as refuge or feeding areas. To the extent practicable, any native fish and rainbow trout entangled during mechanical harvesting would be returned to the waterbody, but some individuals be injured or killed in the process. The number of fish entangled during mechanical harvesting is expected to be small because fish are more likely to avoid the area when the removal begins.

Overall only low mortality is expected in non-target species, and the action would be stopped if unanticipated impacts to non-target species are observed.

Introduction of YY-Male Fish (Action B1; Experimental Action Outside of Tiers). Introduction of YY-male fish is a new approach to non-native fish management that has been used experimentally on brook trout (*Salvelinus fontinalis*) in Idaho (Schill et al. 2017). This tool is intended to reduce or eliminate the population of non-native fish by skewing the sex ratio of the population toward almost all males. With this technique, males with two Y chromosomes are produced in hatcheries or fish farms from hormonally treated brood stock with techniques that have been used in commercial fish farms for many years. The second generation of untreated YY males are then stocked into the wild population. All of the offspring of wild females and YY males are normal XY males. Over a few generations, reproductive output in the population declines and nearly stops as the proportion of YY males increases relative to the proportion of XY males, and the number of females that are produced decreases (Schill et al. 2017). This control method would likely be used in combination with mechanical removal or incentivized harvest to reduce the total number of reproducing wild non-native target fish. NPS is considering using this alternative for brown trout and green sunfish or other medium to very high-risk species if brood stock exists.

The use of YY-male fish to reduce or eliminate populations of wild fishes has not been widely field tested could affect native fishes within GCNP. For these reasons, many safeguards would be employed to ensure there are not large negative impacts which could constitute impairment. Firstly, smaller scale experiment would be completed either in tributary as part of this project, or in a comparable situation elsewhere by other groups, and this would be evaluated, and a larger scale experiment in this system would only be tried if that smaller test was determined to be successful. Secondly, for any YY male introductions in this system there would be monitoring to see if any thresholds are crossed for YY males moving into areas such as the Little Colorado River reach where they could affect humpback chub via predation and competition, and if those effects seen, the action would stopped and mitigated per the specifications in the

Biological Opinion (through mechanical removal of the YY males or other approved mitigation actions). Thirdly, if the thresholds identified in the Biological Opinion are reached, then the action would be stopped and mitigation actions such as mechanical removal of the YY males would be employed to remove YY males.

Chemical Control Actions targeting Non-Native Fish (C1, C2, C3, C4)

Chemical Control actions include methods such as; overwhelming ecosystem-cycling capabilities (C1; ammonia, oxygen, carbon dioxide, pH, etc.) and application of registered piscicides for control to target non-native fish (C2, C3, C4). Each of these activities have reach specific guidance and may be contained in different Tier categories based on location, and in some cases based on the risk level of the fish species. Activities associated with this action are contained in the Conservation Measures section below; which outlines important application and safety methods that are provided to control, avoid, and minimize possible negative effects to the ecosystem, non-target species, and listed species such as humpback chub and razorback suckers, etc. See Table 1 and associated footnotes in BA for full description of this action. All actions in the mainstem would be spatially limited (C1 limited areas < 0.5 acres, C2-C4 < 5 acres in the mainstem), and for action C4, would be limited to tributary reaches with a natural barrier in GCNP.

For all of these chemical control actions, there would be pre-treatment surveys with relocation of non-target species as well as a large number of safeguards discussed in the Biological Opinion including a chemical treatment plan and permits, appropriate chemical handling and concentrations and conformance to the label restrictions, monitoring and sentinel fish use, use of chemical barriers when appropriate, and use of neutralizing agents when appropriate.

The Selected Action includes intensive monitoring and conservative safeguards, as described in the EA, and that action would be stopped and mitigated if unanticipated impacts to non-target species are observed.

Application of Herbicides (Action C5; Tier 1)

Various registered herbicides may be used in backwater or off-channel areas < 5 ac in size or in tributaries to control highly invasive non-native aquatic plants and algae. Non-toxic dyes may be used in combination with herbicide treatments to mark the areas treated. Chemicals would be used in compliance with NPS, federal, and state regulations, the manufacturer's label, safety data sheets, chemical transport and handling guidelines, and applicator certification requirements. The use of herbicides would be on a very limited basis and only when the threat was high for the targeted species to continue to spread and impact other critical aquatic habitat areas along the Colorado River. All herbicide use would be subject to NPS approval processes in strict adherence to applicable regulations and guidelines. It is anticipated that the small-scale application of approved herbicides would have only negligible impacts to non-target aquatic resources. The Selected Action includes conservative safeguards, as described in the EA, and the action would be stopped and mitigated if unanticipated impacts to non-target species are observed.

Application of Mollusk Repellents and Non-Toxic Antifouling Paints (Action C6; Tier 1)

It is anticipated that the proposed applications of this action to boat hulls or water structures would not result in direct physical impacts to aquatic habitat within the project area. For this reason, this action would not constitute impairment of the aquatic resources.

In summary, based on the discussion above and analysis in the EA, the Selected Action will result in impacts that are of limited severity and duration, and actions would cease if unanticipated effects are observed. Aquatic resources will continue to exist in a manner that can be enjoyed by current and future generations. Therefore, water resources will not be impaired by implementing the Selected Action.

Vegetation

Several actions included in the Proposed Action, such as incentivized harvest (Action H1), mechanical removal (Action M2), mechanical disruption of habitats (Action M1), acoustic fish deterrent and guidance devices (Action M3), and temperature control (Action P5) could result in minimal localized impacts from trampling of shoreline vegetation by those implementing the actions. Affected vegetation would be expected to quickly recover to pre-disturbance conditions. The placement of weirs and barriers (Actions P2, P3) could result in a localized loss of vegetation where placement requires soil disturbance. YY male introduction (Action B1), chemical controls using piscicides (Actions C2, C3, C4), and mollusk repellents (C5) would have no impact on terrestrial vegetation.

Dewatering of off-channel ponds and backwaters (Action P1) would result in a reduction in soil moisture levels and subsequent desiccation of riparian vegetation along the perimeter of the pond or backwater unless water levels were restored quickly through natural recharge. Long-term or repeated dewatering could result in a loss of riparian vegetation or transition to drought-tolerant upland vegetation types, and vegetation loss could increase the potential for erosion on the margins of the pond. Ecosystem cycling control (Action C1) could result in some impact to vegetation if contacted by chemicals used.

Dredging to connect the Upper and Lower Sloughs (Action P4) to drain the Upper Slough and facilitate the use of a water-control structure at the outlet of the Upper Slough would result in disturbance of a small area (< approximately 3,400 ft^2). Existing vegetation in the area of the water-control structure would be removed. Installation of a water-control structure would allow draining for control of both invasive animals and plants and refilling would be through natural recharge. However, some loss of riparian vegetation may result from prolonged desiccation while refilling occurs.

Mechanical harvest of non-native aquatic plants (Action M4) and application of herbicides (Action C5) would not affect terrestrial vegetation communities except for short-time periods (days or weeks) in areas trampled during implementation of the actions. Harvested plants and algae would be placed in compost piles on upland sites near the harvest area or in offsite landfills.

No plant species protected under the Endangered Species Act or other special status plant species would be expected to be impacted by this action. Overall, there would be no lasting impacts to the terrestrial vegetative community from these actions.

While vegetation would be impacted in very spatially limited areas, no meaningful, lasting impacts to the terrestrial vegetative community would occur. The integrity of these vegetation resources will not be harmed, and these resources will continue to exist in a manner that can be enjoyed by current and future generations. Therefore, no impairment to vegetation would occur from implementation of the Selected Action.

Wildlife

No actions are expected to impact the Kanab ambersnail given the limited distribution of this species and the measure in the Biological Opinion precluding chemical, mechanical removal, or mechanical harvesting of aquatic plants and algae within 330 ft (100 m) of known locations of Kanab ambersnail.

Some of the control actions under the Proposed Action could affect amphibians occupying habitat in and around ponds and backwaters where control actions are implemented. These options include mechanical disruption (Action M1), acoustic fish deterrent and guidance devices (Action M3), dewatering of off-channel ponds and backwaters (Action P1), ecosystem cycling control (Action C1), piscicide application (C2, C3, and C4) dredging to connect the Upper and Lower Sloughs (Action P4), mechanical harvest of non-native aquatic plants (Action M4), and application of herbicides (Action C5). These options could directly adversely impact amphibians from mortality or result in indirect impacts through loss of habitat. However impacts would be small and limited. Chemical treatments could impact on larval forms of both frogs and

salamanders, though these effects would be localized in the small treatment areas and would have negligible effects at the population level. Removal of non-native fish would benefit amphibian populations by reducing predator pressure in off-channel ponds and sloughs.

Special status species that may occur in or near riparian areas, and, therefore, may be present near the locations where control actions are implemented include: California condor, southwestern willow flycatcher, western yellow-billed cuckoo, Ridgway's rail (Yuma), and bald eagles. Species that breed in riparian vegetation upstream of Lake Mead include the southwestern willow flycatcher, western yellow-billed cuckoo, and Ridgway's rail (Yuma). Disturbance of these species may result from any of the control actions, particularly those with appreciable noise generation, such as the operation of helicopters, pumps, propane heaters, generators used during electrofishing, generators or pumps used when implementing acoustic fish deterrent and guidance actions, pumps used for pressure washers for treating spawning beds, construction equipment during dredging, or additional motorized river trips. However, given the conservation measures in the Biological Opinion, noise-related impacts would be temporary, lasting only for the duration of the activity (the hours of equipment operation), and may result in flushing but would be unlikely to result in nest abandonment or changes in significant behavioral activity or important life requirements such as nesting, roosting, foraging, rearing, and movement activities and habitat.

Another possible impact on birds or mammals could come from consuming fish killed by chemical treatments with rotenone and antimycin, or drinking treated water, however the concentrations that would be used and the conservation measures in the Biological Opinion, these treatments will have no effect on the health of these organisms.

In summary, because the Selected Action is expected to have negligible effects on most terrestrial wildlife species or only small localized effects which would not affect species at the population level, the integrity of these resources will not be harmed, and these resources will continue to exist in a manner that can be enjoyed by current and future generations. Therefore, wildlife will not be impaired by implementation of the Selected Action.

Cultural Resources

Given the nature of the proposed action and the location of most archeological resources, no impacts are expected. The Spencer Steamboat is in the mainstem of the Colorado River, however conservation measures will preclude activities close to the structure and therefore no impacts are expected. Some Tribes, primarily the Pueblo of Zuni and the Hopi tribe, have expressed their concerns regarding lethal management actions applied to non-native fish and other aquatic species repeatedly over the past 10 years. Impacts to aquatic life are perceived as impacts to constitute element of the tribal TCPs encompassing the entire canyon. This includes impacts from lethal aquatic species management and monitoring actions and the experimental introduction of YY-male non-native fish. Chemical control actions, if used, could also adversely affect water quality for relatively short periods (up to several weeks) and in relatively small treated areas (< 5 ac for backwaters and off-channel ponds and some tributaries). With the use of a tiered and adaptive approach that uses less management intensive actions first and with a programmatic agreement developed with the tribes that includes a number of mitigations, cultural resources will remain in a condition that can be enjoyed by current and future generations. Therefore, implementation of the Selected Action will not result in impairment to cultural resources.

Other Resources

As was documented in the EA, the Selected Action was found to have negligible or no impacts on other resources such as air quality, visual/scenic resources, paleontological and geological resources, soils and soundscapes. See Sections 1.3.1 and 1.3.2 of the EA for more information. These resources will remain in state similar to current conditions, and will remain available to be enjoyed by current and future generations. Therefore, they will not be impaired by implementation of the Selected Action.

Conclusion

In the best professional judgment of the NPS decision-maker, based upon the analysis in the EA, relevant scientific and scholarly studies, advice or insights offered by subject matter experts and others who have relevant knowledge or experience, and the results of civic engagement and public involvement activities, implementation of the Selected Action, will not result in impairment of park resources or values

References

AGFD, 2012, *Piscicide Treatment Planning and Procedures Manual*, Arizona Game and Fish Department, May 2012.

EPA (U.S. Environmental Protection Agency), 1992, *Capsaicin R.E.D. FACTS*, fact sheet summarizing information in the Reregistration Eligibility Document for capsaicin, EPA-738-F-92-016, U.S. Environmental Protection Agency.

Finlayson, B., D. Skaar, J. Anderson, J. Carter, D. Duffield, M. Flammang, C. Jackson, J. Overlock, J. Steinkjer, and R.Wilson, 2018, *Planning and Standard Operating Procedures for the Use of Rotenone in Fish Management—Rotenone SOP Manual*, 2nd edition. American Fisheries Society, Bethesda, Maryland.

Healy, B., R. Schelly, C. Nelson, E. Omana Smith, M. Trammell, and R. Koller, 2018, *Review of Effective Suppression of Nonnative Fishes in Bright Angel Creek, 2012-2017, with Recommendations for Humpback Chub Translocations*. Report prepared for the Upper Colorado, Bureau of Reclamation.

NPS, 2006, Management Policies. Available at https://www.nps.gov/policy/MP_2006.pdf. Accessed August 31, 2018.

NPS, 2011. Guidance for Non-Impairment Determinations and the NPS NEPA Process. Available at https://www.nps.gov/subjects/nepa/upload/Supplemental-Guidance_Non-Impairment-Determination-2011_accessible.pdf. Accessed December 19, 2018.

Runge, M.C., C.B. Yackulic, L.S. Bair, T.A. Kennedy, R.A. Valdez, C. Ellsworth, J.L. Kershner, R.S. Rogers, M.A. Trammell, and K.L. Young, 2018, *Brown Trout in the Lees Ferry Reach of the Colorado River—Evaluation of Causal Hypotheses and Potential interventions*, U.S. Geological Survey Open-File Report 2018–1069, 83 p., https://doi.org/10.3133/ofr20181069.

Schill, D.J., K.A. Meyer, and M.J. Hansen, 2017, "Simulated Effects of YY-Male Stocking and Manual Suppression for Eradicating Nonnative Brook Trout Populations," *North American Journal of Fisheries Management* 37:1054-1066.

USACE (U.S. Army Corps of Engineers), 2013, *Acoustic Fish Deterrents*, Available at http://glmris.anl.gov/documents/docs/anscontrol/AcousticFishDeterrents.pdf. Accessed November 14, 2018.

Zale, A.V., D.L. Parrish, and T.M. Sutton, 2012, *Fisheries Techniques*, American Fisheries Society, Bethesda, MD.

ATTACHMENT D: BIOLOGICAL OPINION

United States Department of the Interior

Fish and Wildlife Service
Arizona Ecological Services Office
9828 North 31st Avenue, Suite C3
Phoenix, Arizona 85051
Telephone: (602) 242-0210 Fax: (602) 242-2513

In Reply Refer To:
AESO
02EAAZ00-2019-F-0214

March 04, 2019

Memorandum

To: Superintendents, Grand Canyon National Park and Glen Canyon National Recreational Area. Attention: Rob Billerbeck and Jenny Rebenack

From: Field Supervisor

Subject: Biological Opinion and Concurrence for the Glen Canyon National Recreation Area and Grand Canyon National Park Expanded Non-native Aquatic Species Management Plan

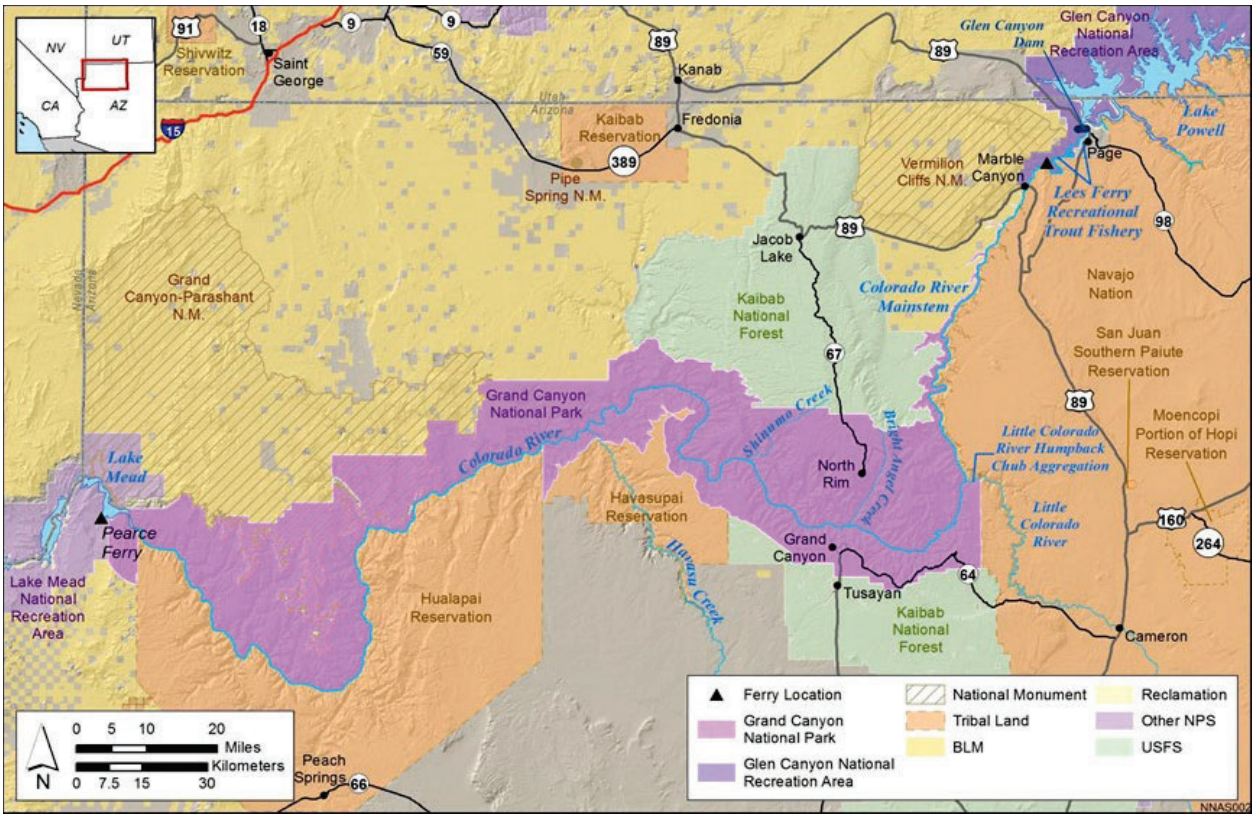
Thank you for your correspondence received November 28, 2018, requesting consultation with the U.S. Fish and Wildlife Service (Service) for the Expanded Non-native Aquatic Species Management Plan (NNAS), in compliance with section 7 of the Endangered Species Act of 1973 (ESA) as amended (16 U.S.C. 1531 et seq.). The National Park Service (NPS) has requested formal and informal consultation regarding their proposed NNAS for management actions that will occur in Glen Canyon National Recreational Area (GCNRA) and Grand Canyon National Park (GCNP); Coconino County, Arizona. A full description of the action can be found in the NPS Environmental Assessment (EA), EA errata, and Biological Assessment (BA). The NPS proposes an adaptive management approach that includes tools to manage current and possible future detected, non-native aquatic species. The NNAS provides means of management that are to work in addition to, and in conjunction with, their existing Comprehensive Fish Management Plan (CFMP); and that importantly maintain NPS' Section 7(a)1 responsibilities under the ESA. Undesirable aquatic non-native species can pose threats to listed fish species in the action area, and therefore a plan to minimize these non-native species, and their possible impacts, is recovery minded. The Proposed Action provides additional tools to the CFMP that are expected to provide better short- and long-term control of non-native aquatic species with little risk to other resources. The tiered and adaptive approach of the Proposed Action identifies safeguards for adjusting or stopping actions, if unacceptable adverse impacts are observed, or are projected to occur.

The NPS has concluded that the proposed action "may affect, and is likely to adversely affect" the endangered humpback chub (*Gila cypha;* chub) and razorback sucker (*Xyrauchen texanus;*

sucker) and associated designated critical habitat. We agree with the determination and provide the following Biological Opinion (BO). The NPS has concluded the proposed action "may affect, but is not likely to adversely affect" the Mexican spotted owl (*Strix occidentalis lucida*), southwestern willow flycatcher (*Empidonax traillis extimus*), western yellow-billed cuckoo (*Coccyzus americanus*), Yuma Ridgway's (clapper) rail (*Rallus obsoletus*); nor will it prohibit recovery of the California condor (*Gymnogyps californianus*) and the 10(j) population that exists in the project footprint. We concur with your determinations and provide the rationale for our concurrence in Appendix A of this BO. In addition, NPS has made a "no effect" determination for Kanab ambersnail (*Oxyloma haydeni kanabensis*), Sentry milk-vetch (*Astragalus cremnophylax cremnophylax*), Brady's pincushion cactus (*Pediocactus bradyi*), and Fickeisen plains cactus (*Pediocactus peeblesianus fickeiseniae*). Concurrence with, "no effect" determinations is not required, and thus these species will not be addressed further in this document; however, the rationale for doing so is documented in the NPS BA.

This BO is based on information provided in the NPS EA, draft EA errata, BA, telephone conversations, meetings between staff, and other sources of information found in the administrative record supporting this BO. The full NPS EA can be found at the following link; http://parkplanning.nps.gov/Expanded_Nonnative
https://parkplanning.nps.gov/document.cfm?parkID=62&projectID=74515&documentID=90478
Literature cited in this BO is not a complete bibliography of all literature available on the species of concern. The before mentioned documents provided by NPS are collectively considered the BA for this proposed action, and this BO. A complete administrative record of this consultation is on file at this office.

Figure 1. General Project Area for the Expanded Non-Native Aquatic Species Management Plan



CONSULTATION HISTORY

October 23, 2017	The NPS sought comment on alternatives considered in the Non-native Aquatic Species Environmental Assessment (EA) and began early consultation with the Service.
January 4, 2018	Meeting between NPS and Service to discuss a process and timeline for consultation.
March 19	Service receives outline of the BA for review.
May 29	Service receives sections of the draft BA for input. Subsequent and intermittent phone calls took place between the NPS and Service.
October 4	Service and NPS conference call to discuss conservation measures.
October 16	Service and NPS conference call to further discuss YY-males and additional YY-males conservation measures.
October 25	Service receives initial draft of the BA.
November 14	Service and NPS conference call to discuss comments on the draft BA.
November 26	Service and NPS conference call to discuss YY-male conservation measures.
November 27	The NPS sent Service the final BA.
November 28	Service receives final BA.
December 22	Federal Government Furlough begins
January 25, 2019	Federal Government Furlough ends
January 31, 2019	Service and NPS conference call to discuss updated timeline and draft BO questions
February 11	Draft BO sent to NPS
Date	Service receives comments on Draft BO

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

The purpose of the Proposed Action is to provide additional tools beyond what is available under the CFMP and the Bureau of Reclamation's (Reclamation) Long-term Experimental and Management Plan (LTEMP) to allow the NPS to prevent, control, minimize, or eradicate potentially harmful non-native aquatic species, and the risk associated with their presence or expansion, in the project area.

Future management actions may be needed due to an increase in green sunfish (*Lepomis cyanellus)* and brown trout (*Salmo trutta*) and potential expansion, or invasion, of other non-native aquatic species that threaten downstream native aquatic species, including listed species; such as humpback chub and razorback sucker. Non-native species have become an increasing threat due to changing conditions since completion of the CFMP and LTEMP. Existing measures identified in the CFMP and the LTEMP may be inadequate, in and of themselves, to address harmful non-native aquatic species.

Recent increases in the non-native green sunfish and brown trout in the Glen Canyon reach have prompted concerns about risks to humpback chub and razorback sucker in downstream areas (Runge et al. 2018; Ward 2015). Green sunfish and brown trout are not native to this location and had been observed in small numbers, but have recently been reproducing in larger numbers in this reach. Both species have high predation rates on native fish (Yard et al. 2011; Runge et al. 2018; Marsh and Langhorst 1988; Whiting et al. 2014; Ward 2015), raising concerns that large populations of these species in the Grand Canyon or the Glen Canyon reach could lead to large numbers of individuals migrating downstream where they could negatively impact the endangered humpback chub population. The Proposed Action identifies adaptive approaches to manage these threats as they appear over time.

The Proposed Action includes additional tools that could be used downstream of Glen Canyon Dam in GCNRA and in GCNP over the next 20 years. For the purposes of this Proposed Action, potentially harmful non-natives are defined as those fish, aquatic plants, or aquatic invertebrate species that are not native to the action area and that may pose a threat to native species (including federally or state listed or sensitive aquatic species). The list of potentially harmful non-natives includes; but is not limited to, brown trout, catfish species (Ictaluridae), bass and sunfish (Centrarchidae), striped bass (*Morone saxatilis*), cichlids (Cichlidae), perch and walleye (Percidae), new carp species (Cyprinidae), northern pike (*Esox lucius),* Asian clam (C*orbicula fluminea*), quagga mussel (*Dreissena bugensis*), didymo (*Didymosphenia geminata*), Eurasian watermilfoil (*Myriophyllum spicatum*), hydrilla (*Hydrilla verticillata*), and other non-native aquatic species detected in GCNRA or GCNP. Some of these species occur in Lake Powell and may enter the area through Glen Canyon Dam; however, there are other possible sources of non-native introduction including accidental tributary or river introductions.

The Proposed Action is expected to provide better short- and long-term control of non-native aquatic species with little risk to other resources. The tiered and adaptive approach of the Proposed Action identifies safeguards for adjusting or stopping actions if unacceptable or

unanticipated adverse impacts are observed or projected to occur. Control actions that could be applied under the Proposed Action, and their respective tiers, triggers, off-ramps, and mitigation actions are presented in Table 2-1 of the EA and Table 1 of the BA. Tiers, triggers, and off-ramps are designed to balance the need to use the most effective methods necessary, while avoiding using deleterious methods unless necessary, by demonstrating lower Tiers being ineffective. Off-ramp parameters are defined by activities, but are generally defined in this document as criterion or environmental conditions that once met would result in a cessation of the associated activity that may be causing them, or that may exacerbate impacts beyond an acceptable or anticipated level. A full description of the action and associated Conservation Measures are included in the BA, are incorporated within this BO by reference, and are summarized below.

Control actions are separated into the following five categories:

- *Targeted harvest:* changing harvest rates to increase removal of non-native aquatic species.
- *Physical controls:* habitat modification or exclusion of specific areas less than 5 ac in size that are identified as source areas or non-native habitat areas for harmful non-native aquatic species.
- *Mechanical controls:* physical removal of non-native aquatic species from habitats.
- *Biological controls:* introduction of organisms to control populations of non-native aquatic species.
- *Chemical controls:* limited application of chemicals to control populations of non-native aquatic species.

Targeted Harvest

The NPS may organize incentivized harvest methods (H1) which may include a combination of guided fishing efforts with Tribal members and volunteers, tournaments, prize fish, restoration rewards for target fish harvested and removed, or similar tools in the Glen Canyon reach of Glen Canyon NRA. This method will initially focus on brown trout but may include other aquatic non-native species detected in the future. This activity is a Tier 1 method and can be used at any time and is triggered by non-native species presence. Should this method be found ineffective or have adverse impacts beyond what is anticipated, this action will cease. This action would occur in cooperation with Federal and Non-Federal partners. Targeted harvest is not planned in GCNP. See Table 1 and associated footnotes in BA for full description of this action.

Physical Control

Physical controls include methods such as; dewatering relatively small ponds and backwater areas by high-volume portable pumps for short time periods (no more than 2 weeks total, excluding refill time which may require an additional 7 days), placement of selective weirs to disrupt spawning or new invasions, placement of non-selective barriers to restrict access to

tributaries, backwaters, and off-channel habitat areas, production of small scale temperature changes using a propane heater to adversely affect coldwater non-native fish, and dredging/placement of water control structures in small ponds or backwaters. See Table 1 and associated footnotes in BA for full description of this action. Should any of these methods be found ineffective or have adverse impacts beyond what is anticipated, this action will cease.

Dewatering of small ponds and backwaters (P1) may be used in Glen Canyon NRA including but not limited to, the 12-Mile Slough (upper slough only), and in small ponds and backwaters attached to the mainstem Colorado River and associated tributaries in GCNP. Additionally, placement of selective weirs (P2) and non-selective barriers (P3) will be used to restrict aquatic non-native access to tributaries, backwaters, and off channel habitats in Glen Canyon NRA and GCNP. Dewatering activities, selective weirs and non-selective barriers are a Tier 1 method and can be used at any time and is triggered by non-native species presence.

Production of small scale temperature increases to disadvantage cold water non-native fish (P5) may occur in tributaries to the Colorado River in GCNP. This activity is experimental, outside of the Tier schema, and may be triggered by detection of any cold water non-native aquatic fish.

Dredging may occur at the 12-Mile Sloughs in Glen Canyon NRA (P4). This dredging would be contained within, and between, the Upper and Lower Sloughs and would facilitate the complete initial draining of the upper slough, and any subsequent drainings needed, to remove a majority of the non-native fish (especially warmwater species). This activity would also include the installation of water control infrastructure in order to maintain the wetland and current wildlife habitat values. Dredging and associated activities is a Tier 4 activity and will only be used should activities in Tiers 1, 2, and 3 be ineffective. This would be a one-time event and as such would not have off-ramps to cessation of activity.

Mechanical Control

Mechanical control includes methods such as; mechanical removal by electrofishing (boat, barge, and backpack units) and trapping, mechanical disruption of early life stage habitats at spawning sites by high-pressure water flushing and mechanical gravel displacement, acoustic fish deterrent and guidance, and mechanical harvesting of non-native aquatic plants. Each of these activities have reach-specific guidance and may be contained in different Tier categories based on location, and in some cases based on high risk fish species. See Table 1 and associated footnotes in BA for full description of this action.

Mechanical removal methods include electrofishing and various trapping net mechanisms for the long-term control of aquatic non-native fish species. This method is anticipated to capture and remove fish with relocation of live fish, or beneficial use of dead fish when applicable, permitted, and possible. Mechanical removal (M2) is a Tier 3 activity in the GCNRA reach when targeting brown trout; and includes the following parameters for implementation;

LTEMP triggers for mechanical removal of trout at the Little Colorado River (LCR) confluence have been exceeded and mechanical removal is being implemented there or has been proposed for the following year,

AND

Brown trout are a contributing proportion of the fish predators in the Little Colorado River reach (e.g., 6 adult brown trout h [>350 mm] caught in the current or previous year in the Juvenile Chub Monitoring [JCM] reach [River Mile {RM} 63.5-65.2]),

AND

Brown trout production in the Glen Canyon reach is an important contributor to the number of adults in the Little Colorado River reach (i.e., the number of adult brown trout in the Glen Canyon reach is > 5,000),

OR

LTEMP triggers for mechanical removal of trout in the Little Colorado River reach have not been met, but monitoring data and modeling indicate the number of adult brown trout is > 20,000 in the Glen Canyon reach, which modeling using moderate-risk parameters indicates that the population of adult brown trout would reach 47 in the JCM reach, the threshold above which mechanical removal at the Little Colorado River confluence would be ineffective in controlling further increases.

If mechanical removal has ceased at the Little Colorado River confluence and if brown trout adults in the Glen Canyon reach have decreased to below 10,000 then mechanical removal would cease until the initiation trigger of > 20,000 is reached again.

Mechanical removal (M2) is a Tier 2 activity in GCNRA for all other species, to be implemented when Tier 1 methods are shown or projected to be ineffective and there is a threat of dispersal or increase. At the 12-Mile Sloughs and inside GCNP this is a Tier 1 action that is triggered by non-native presence. For all areas, this activity will cease if this control action is ineffective in removing or controlling a majority of non-native fish, adequate funding is not available, or long-term unacceptable adverse effects on native fish or other important resources are expected or observed.

Implementing mechanical disruption in early life stage habitats at spawning sites (M1) will include the use of high-pressure water flushing and mechanical displacement of gravel. This method is anticipated to displace eggs, larvae and young non-native fish from spawning and nursery locations. This is a Tier 2 activity with specific implementation parameters at different locations and by species. This method would be used to target brown trout spawning locations, within GCNRA, if the estimated number of brown trout adults (>350 mm long) in the Glen Canyon reach exceeds 5,000 and there is evidence that reproduction in Glen Canyon is contributing to the continued increase. If brown trout adults decrease to below 2,500, then mechanical disruption would cease. For all other areas and other aquatic non-native fish species, this activity would be triggered if Tier 1 actions are shown or projected to be ineffective and there is a threat of dispersal or increase. Should these methods be found ineffective or have adverse impacts beyond what is anticipated, this action will cease.

The use of acoustic fish deterrent and guidance activities (M3) are Tier 1 actions that may take place at any location in the action area; inside backwaters, off-channel ponds, and low velocity areas less than 5 acres in size. The trigger for this activity is presence of aquatic non-native fish species that may be deterred from target areas that are defined as future detection and management dictates. Should these methods be found ineffective or have adverse impacts beyond what is anticipated, this action will cease.

Mechanical harvesting of aquatic non-native plant species (M4) may occur at any off-channel location, including tributaries inside the action area and will include areas that are less than 5 acres in size. This method is a Tier 1 activity that is triggered by presence of non-native aquatic plant species, and will cease should this method be ineffective or be found to have adverse impacts beyond what is anticipated. Additional regrading of gravel may be necessary in areas once treatment is complete.

Biological Control

The introduction of non-native fish into the action area may occur in an attempt to use new technologies that focus on the long-term management of undesirable fish populations. One such experimental technology is the creation of male populations in which sex chromosomes are modified through hormonal adjustments and brood stock management. This results in male fish that can reproduce but their resulting offspring are males only. Population models based on this technology indicate that by drastically skewing the population towards males, there could be a decrease in the overall population. For salmonid species, in the first generation male fish have a YY sex chromosomal makeup, rather than the typical XY. Second generation male fish are normal XY males. In other species, the overall concept of hormonally adjusted sex chromosomes and male population skewing is the same, but may result in the characteristics of sex chromosomal makeup being species specific (i.e. ZW/ZZ forced to WW). Currently, this technique is in the experimental phase, but has shown some success with brook trout. Should YY-male brown trout broodstocks, or broodstocks of other non-native fish species become available, this technology may be used inside the action area as part of this current management plan.

This method (B1) will be used cautiously and incorporates safeguards that will avoid or mitigate possible effects to listed and sensitive species as much as possible; included in the Conservation Measures section below. Currently, no brood stock is available for this action; however, development of brood stock for brown trout and walleye is underway and could be available in the next 5 years, possibly sooner. Green sunfish is being evaluated as a possible species for brood stock, however, there may be biological barriers to that development. As noted in Conservation Measure (CM)-13, NPS will first conduct a pilot of brown trout YY-male introduction on a limited basis (2-5 years) in GCNP if a comparable study has not yet been successfully completed by another agency elsewhere. This NPS pilot would occur in Bright Angel Creek or a similar tributary. All YY-males would be PIT tagged in the pilot study to determine migration and survival rates. If a pilot is attempted and successful or other project locations (not part of this proposed plan) show positive results, and after communication and agreement with the Service, NPS may consider introducing YY-male brown trout in the Glen Canyon reach with up to 5,000 adult fish per year (or comparable numbers of juveniles). The

NPS would communicate with the Service if the NPS plans to introduce YY-males of species other than brown trout, or if locations other than Glen Canyon reach, or stocking numbers other than those specified in the EA were being contemplated. Also, if prior to the availability of brood stock for YY-male brown trout, new modeling or studies become available for brown trout YY males that suggest potentially different mortality/survivorship or migration values or other significant parameters, then NPS would reassess and communicate or consult with the Service as needed. Species and site-specific parameters will be implemented as part of this experimental approach. YY-male brown trout may be stocked into the Glen Canyon reach under the following environmental conditions:

- Experimental evidence and modeling indicate the action may be effective and brown trout adults (>350 mm long) are present in the reach.
- Annual stocking would be initially limited to a maximum of 5,000 adult YY-male brown trout, or an equivalent number of juveniles (estimated to be 10,000 based on assumed juvenile survival rates).
- This number represents a conservative level of risk to humpback chub if survival, movement, and predation rates are at high-risk levels.
- If wild brown trout adults in the Glen Canyon reach are not observed during monitoring for 3 years, then YY-male introduction may cease.

Should other brood stocks using similar methods become available and these species are present in the Glen Canyon reach or into tributaries to the Colorado River in GCNP, then NPS may introduce these broodstocks in a similar manner (including use of Conservation Measures) in coordination with the Service. This experimental action may take place if experimental evidence and modeling indicate that action may be effective, and target non-native fish are present in the area that may pose a medium to very high risk to humpback chub and razorback sucker. See Conservation Measures for full action.

Chemical Control

Chemical control actions includes methods such as; overwhelming ecosystem-cycling capabilities (C1; ammonia, oxygen, carbon dioxide, pH, etc.) and application of registered piscicides for control to target non-native fish (C2, C3, C4). Each of these activities have reach specific guidance and may be contained in different Tier categories based on location, and in some cases based on risk level of the fish species. Activities associated with this action are contained in the Conservation Measures section below; which outlines important application and safety methods that are provided to control, avoid, and minimize possible negative effects to the ecosystem, non-target species, and listed species such as humpback chub and razorback suckers, etc. See Table 1 and associated footnotes in BA for full description of this action.

Overwhelming ecosystem-cycling capabilities may be effective at removing non-native aquatic fish species. This action may occur in small backwaters or off-channel areas in GCNRA, in the upper pool of the 12-Mile Slough, or in the action area within the GCNP as a Tier 3 action (i.e. Tier 1 and 2 is ineffective and threat of dispersal or increase of non-native populations). This activity will cease if this control action is ineffective in removing or controlling a majority of

non-native fish, adequate funding is not available, or long-term unacceptable adverse effects on native fish or other important resources are expected or observed. NPS will take actions to remove and relocate a majority of the non-target native species where feasible prior to a treatment.

Application of registered piscicides within the action area will fall under a variety of Tiers based on non-native species threat, stage of invasion or establishment, or location. Activities in the GCNRA reach and the -12 Mile Slough fall under Tier 3 (either C2 rapid response application for new invasions of medium to very high risk or C1 experimental use of natural substances to overwhelm ecosystem-cycling capabilities in the -12 mile upper slough, backwaters, or off-channel areas, and low velocity areas <5 acres) and Tier 4 (application focused on high and very high-risk species (C3) in the -12 mile sloughs, backwaters, or off-channel areas, and low velocity areas <5 acres) actions; each being triggered by all previous activities in lower Tiers being ineffective. In other parts of GCNRA, actions C1, C2 or C3 may be used per the constraints specified in Table 1 and associated footnotes in BA.

In GCNP, application of registered piscicides will occur as Tier 2 activities in the tributaries for the purposes of tributary renovation (C4); when action of Tier 1 or control actions of the CFMP are shown or projected to be ineffective. Tributary renovation will occur in tributaries with natural barriers only. Use of registered piscicides will also occur in backwaters, off-channel ponds, and low velocity areas <5 acres in GCNP for the purposes of rapid response. Rapid response application (C2) is a Tier 3 action for any new harmful non-native aquatic species rated medium to very high risk. Lastly, application of registered piscicides may be used as a Tier 4 action for long-term control of any high to very high-risk species (C3) in GCNP backwaters, off-channel ponds and low-velocity areas <5 acres only after lower tiers have been shown to be ineffective. These activities will cease should control action be shown to be ineffective in removing or controlling a majority of non-native fish, adequate funding is not available, or long-term unacceptable adverse effects on native fish or other important resources are expected or observed.

Management of high- to very high-risk aquatic plants or algae (C5) may require the application of herbicides and non-toxic dyes to backwaters, off-channel areas, and tributaries of the Colorado River inside the action area. This method is a Tier 1 activity and could be triggered by presence of plants and algae, in off-channel areas less than 5 acres or in low-velocity reaches of the tributaries. Also, a Tier 1 activity, mollusk repellents and non-toxic anti-fouling paints (C6) may be used on boats, equipment used in the river and NPS water intakes. Both sets of activities have associated conservation measures. These activities would cease if found that they are ineffective in controlling non-native plants or algae, are not inhibiting the attachment of invasive mussels, adequate funding is not available, or long-term unacceptable adverse effects on native fish or other important resources are observed.

Conservation Measures

Conservation measures that avoid or mitigate impacts to species that are likely to be adversely effected by these actions (humpback chub or razorback sucker) are listed in this section.

Conservation measures that are designed for species with a determination of "may affect, not likely to be adversely affected" are outlined in the Appendix A: Concurrence, section of this document. Other conservation measures that were provided in the BA for species with a "no effect" determination are not included in this document, but are provided in the BA and are therefore part of the administrative record and can be requested from NPS or the Service (AESO).

CM-1. Pre-Treatment Surveys to Avoid Impacts to Endangered Fish:
As necessary, surveys would be conducted in the immediate area of a control action for endangered fish prior to initiation of the action. If endangered fish are found, and unless otherwise specified, NPS will assess whether to continue with the action and will apply the appropriate conservation measures as outlined below. Measures in CM-5 and CM-6 would be used to minimize impacts from the survey itself.

CM-5. Mechanical Removal/Electrofishing Conservation Measures (M2):

- & Electrofishing gear will be set to avoid injury to all fishes, including rainbow trout in Lees Ferry; the least-intensive electrofishing settings that effectively stuns and captures fish will be used in most cases. For example, during tributary electrofishing in Grand Canyon, a pulsed-DC at a frequency of 30-40 Hz (300-350 volts) has proven to be sufficient in minimizing mortality to both non-native trout and native fishes. However, if no native or non-target species are present in backwater or off-channel areas, settings may be altered to maximize the capture of target species.
- & In tributaries where humpback chub have been released, electrofishing equipment use will be minimized in large-volume, deep pools where gear is less effective in capturing fish, and where humpback chub tend to congregate.
- & In tributaries or small backwaters, during multiple-pass depletion electrofishing, native fish will be retained in holding areas between passes, or released in a manner that will minimize the likelihood of repeated electrofishing (i.e., away from the sampling areas).
- Non-target fish captured using electrofishing will be monitored in buckets, and gear settings would be adjusted if sufficient shock recovery is not observed.
- Crew members will be sufficiently trained in electrofishing techniques.

CM-6. General Fish Handling:

- & Trammel net use will be minimized when possible, and will not be used if water temperatures exceed 20°C, in areas with known presence of ESA-listed fishes. Trammel nets would be checked every 2 hours or less.
- "General Guidelines for Handling Fish" published by the USGS-GCMRC to minimize injury to non-target fish would be followed during all field projects (Persons et al. 2013).
- During sampling efforts, all native fish will be processed first and handling time on captured listed fish will be minimized whenever possible
- & If incidental mortality occurs, humpback chub and razorback sucker otoliths will be extracted and preserved (if feasible) in 100% ethanol, otherwise the entire fish will be preserved as described in Persons et al. (2013) and deposited into GCNP's museum.
- & In areas with known presence of ESA-listed fishes, and subject to NPS regulations, no bait, or an artificial or natural substance that attracts fish by scent and/or flavor (i.e., live or dead minnows/small fish, fish eggs, roe, worms, or human food), would be used by

anglers participating in non-native fish control efforts. If angling is used in any mechanical removal efforts in GCNP, then barbless hooks would be used for trout removal activities in areas with known presence of listed fishes.

CM-7. Aquatic Invasive Species (AIS) Prevention Measures

- Standard quarantine/hatchery pathogen and disease testing and treatment procedures will be followed to prevent the transfer of AIS from one water to another during live transport of non-native fish species; currently only proposed for green sunfish removed from the 12-Mile Slough in GCNRA to Lake Powell.
- To prevent inadvertent movement of disease or parasitic organisms among aquatic sites, research and management activities shall conform to the Declining Amphibians Population Task Force Field Work Code of Practice (www.nrri.umn.edu/NPSProtocol/pdfs/Amphibians/Appendix%20B.pdf), with the exception that 10% bleach solution or 1% quaternary ammonia should be used to clean equipment rather than 70% ethanol. Abiding by this code will effectively limit the potential spread of pathogens via fish sampling equipment.

CM-11. Conservation Measures When Using Piscicides (Rotenone, Antimycin or Ecosystem Cycling Treatments, Action C1, C2, C3, C4):

- For Actions C1, C2, C3, and C4, if any humpback chub or razorback sucker are found during pre-treatment surveys or if there is reason to believe the treatment area is occupied and critical for spawning and rearing, NPS would communicate with the Service AESO prior to conducting these actions to determine whether to halt this action in this area or conduct salvage relocation.
- NPS would not implement Actions C1, C2, C3, or C4 in the same location for more than 5 consecutive years. If this action is not effective as a long-term solution when implemented over a 5-year period under the implementation of this Proposed Plan, NPS would pursue additional planning and compliance for any subsequent actions not included within this BA.
- Registered piscicide treatments (C2, C3, or C4):
    - NPS would seek state permits and follow state treatment plan requirements and guidelines. Additionally NPS would follow the NPS approval process and required pesticide use plan. Rotenone or antimycin would be applied in accordance with labels and the appropriate standard operating manuals (Finlayson et al. 2010; Moore et al. 2008). Formulations and application rates would be selected to minimize potential effects for birds and mammals and minimize toxicity to aquatic invertebrates. These would be used with standard neutralizing agents.
- Experimental treatments to overwhelm ecosystem cycling capabilities (C1)
    - Treatments with naturally occurring compounds (i.e., ammonia, carbon dioxide, pH alteration, or oxygen-level alteration treatments) could be used for research purposes and to control non-native invertebrate, amphibian, and fish species in targeted, small backwater or off-channel habitat areas (Ward et al. 2011; Ward 2015; Treanor et al. 2017).

- ○& These would be limited to small backwater areas (< 5 ac) and would be performed under appropriate state experimental permits through ADEQ or other agencies as required.

●& Chemical treatments under actions C1, C2, C3, C4 would include:

- ○& Standard pre-treatment monitoring and watershed assessment within five days prior of application to ensure the treatment area conditions are accurately characterized and representative. This may include: Secchi depth transparency; water temperature, dissolved oxygen, and pH depth profiles; collection of non-native and native fish for use in bioassays; water flow, water quality and soil samples.
- ○& Barrier construction (if necessary) that could include an impermeable barrier (turbidity curtain) and/or a temporary barrier net may be installed to minimize movement of piscicide from the treatment area into the river (turbidity curtain), and to contain and facilitate removal of dead fish (turbidity curtain and/or net).
- ○& Native species salvage and relocation prior to piscicide treatment using boat or backpack electrofishing or netting/trapping.
- ○& Pre-treatment bioassay of water quality conditions would be conducted (e.g., pH, alkalinity, water temperature, sunlight exposure) as needed for adjustments to treatments.
- ○& Proper storage, transfer and mixing and spill response procedures will be used.
- ○& Fish will be actively removed during and after the treatment and any remaining fish found at the site will be removed and disposed within 48 hr of treatment at a landfill, or left in place if few in number, small in size, or sunken to the bottom and inaccessible to avian and terrestrial scavengers.
- ○& Monitoring would include the use of sentinel fish throughout the treatment area, and immediately downstream of the treatment area.

CM-12. Conservation Measures for Incentivized Harvest (H1)

- NPS would make available educational information to anglers in the Glen Canyon reach in the form of signs or information for the identification of humpback chub and razorback sucker, and other native fish, and provide direction to anglers to return these species to the river.
- NPS would make available educational information to anglers in the Glen Canyon reach to discourage any potential non-native introductions.

CM-13. Conservation Measures for YY Male Introductions (B1)

- NPS will communicate with the Service prior to the first introduction of YY male non-native fish to determine if any new studies or modeling suggests that additional consultation is needed. Modeling for any species of YY male would be based on the spreadsheet model for brown trout YY males (Appendix B) and should include new or revised estimates for annual numbers to be stocked, survival/mortality rates, emigration rates, predation rates, and number of years to stock.
- NPS will work with the Service and the Grand Canyon Monitoring and Research Center (GCMRC) prior to implementation to ensure that introduction of YY males is not expected (based on the modeling and current conditions) to cause the Tier 1 or Tier 2 triggering conditions in the LTEMP BO to be reached due to the YY males introduced

(given the current status of humpback chub population, the estimated predator index in the LCR area, and the estimated number of introduced YY male migrants to reach the LCR). In addition, if the Tier 1 or Tier 2 trigger have already been reached in a given year or are modeled to be reached in the next year, regardless of the YY introductions, then NPS would not introduce YY males in that year.

- Prior to introducing YY male brown trout in the mainstem, a pilot study will be conducted, either by NPS, or a comparable project completed elsewhere by another agency under their own compliance may be substituted.
    - If NPS conducts the pilot study of brown trout YY male introduction, it will be done first on a limited basis for between 2-5 years in a GCNP tributary. Prior to the introduction, NPS will communicate and seek agreement from the Service on the specifics of the stocking level, locations and conditions. The stocking level maximum for a pilot study in GCNP would be 2,000 adult brown trout (or an equivalent number of juveniles adjusted for expected mortality) per year; however, the actual number could be lower based on communication with the Service about current conditions, and the population of brown trout in the action area at that time (e.g. 2017 population of adult brown trout in Bright Angel Creek >230 mm was 626; B. Healy pers. comm. 2018).
    - During the pilot study in GCNP, all brown trout YY males would be PIT tagged to more closely monitor migration and survival rates using existing studies in the tributary and the mainstem, and existing passive antenna arrays.
- Upon conclusion of a pilot study, NPS will communicate about the results with the Service and if there is agreement that this was an applicable and successful study, then NPS may consider a YY male brown trout introduction in the mainstem. NPS may then stock an annual maximum of 5,000 adult brown trout in the Glen Canyon reach (or an equivalent number of juveniles adjusted for expected mortality).
    - After the pilot study, NPS will PIT tag every introduced YY male for the first five years to monitor migration rates. After the first five years, NPS will PIT tag a proportion of the introduced cohort sufficient to continue monitoring migration rates. In addition, NPS will mark or tag all introduced YY males to assist with identification by agencies and anglers.
- YY male non-native fish stocking would be discontinued in a location or for a species if:
    - NPS determines through monitoring or in communication with the Service that the introduced YY male non-native fish are having a negative effect beyond what is estimated based on this consultation process on the humpback chub or razorback sucker populations; or
    - If the rates of survival and migration of YY male brown trout from the stocking location to the Little Colorado River reach are greater than what was modeled; or
    - If the reproductive success of the introduced YY males is determined to be too low to be effective.

  Under these conditions, the NPS would cease introductions and would use mechanical removal or other available tools to remove the introduced YY male non-native fish to reduce and mitigate the threat.

- NPS would communicate and seek agreement with the Service prior to implementation for any new area where YY male brown trout are being considered for introduction.
- Tagging or marking of species other than brown trout would be consistent with the approach discussed above.
- To enhance the effectiveness of this method, NPS would utilize incentivized harvest, mechanical removal or other efforts in conjunction with the YY-introductions to reduce the population of wild brown trout.

CM-14. Conservation Measures for Other Control Actions not Covered Above (M1, M2, M3, M4, P1, P2, P3, P4, P5)

- Monitoring for unintended or unacceptable effects and tracking of non-target native or federally listed species encountered in any treatment areas.
- & When applicable, prior to control treatment, boat electrofishing and/or barge or backpack electrofishing or netting/trapping will be used to survey and, as appropriate, salvage native species. Native species would be relocated live to another stretch of the same river/stream outside of the treatment area.
- & For Action P5 specifically, temperatures would be heated over a period of approximately 8 hr using a propane heater powered by a generator. This would prevent causing temperature shock to the fish. Additionally, NPS would carefully monitor the main channel of the stream below the mixing point to ensure the temperature change is negligible after mixing. Continued monitoring and temperature adjustment would occur after the target temperature is reached.
- & For Actions M1, M3, M4, P1, P3, P5 if any humpback chub or razorback sucker are found during pre-treatment surveys or if there is reason to believe the treatment area is occupied and critical for spawning and rearing, NPS would communicate with the Service prior to conducting these actions to determine whether to halt this action in this area. When practicable, NPS would avoid conducting actions in these areas during spawning season for humpback chub and razorback sucker.

CM-15. Conservation Measures for Mollusk Repellents and Herbicides (C5, C6)

- Aquatic application of herbicides (Action C5) would be applied according to label and would be subject to strict guidelines and controls to protect aquatic species and water quality, including the NPS required pesticide use plan and NPS approval processes in strict adherence with applicable regulations and guidelines. Aquatic applications will only occur in backwater and off-channel aquatic habitats and tributaries.
- Mollusk repellents that contain capsaicin will be used on boats and equipment in the river, or non-toxic anti-fouling paints that do not contain copper and are approved for use in Arizona will be used. All use of repellent and anti-fouling paint would be subject to NPS pesticide use plan and approval processes in strict adherence to applicable regulations and guidelines.

CM-16. Interagency Coordination:

- All sampling activities will be coordinated with AGFD (according to 43 CFR part 24) and the Service Arizona Fish and Wildlife Conservation Office and AESO, as well as the

USGS-GCMRC or other agencies performing fish monitoring or research within the project-area.

- Annual reports documenting implementation and monitoring conducted by the NPS will be provided to the Service, AGFD, Reclamation, USGS and other interested parties.
- & Bi-monthly, or more frequently as needed, conference calls (or written status updates in lieu of a call) will continue to be held by the NPS Fisheries Program to update interested parties on ongoing or new NPS management activities under the Proposed Action.
- & In the selection of an herbicide (Action C5), NPS will consider (1) the site location to be treated, (2) the non-native vegetation, and (3) the time of year and water temperatures. Herbicide selection will be communicated with the Service and Arizona for a NPDES prior to the initiation of the action.
- & If the NPS planned to introduce YY males of species other than brown trout, or in locations other than Glen Canyon reach, or stocking numbers other than those specified in the Proposed Plan were being contemplated, the NPS would communicate and seek agreement with the Service prior to initiation of the action. Also, if prior to the availability of brood stock for YY male brown trout, new modeling or studies become available for brown trout YY males that suggest potentially different mortality/survivorship or migration values or other significant parameters, then NPS would reassess and communicate or consult with the Service as needed. If new information becomes available regarding non-native movement rates and/or predation rates, the model will be re-evaluated to ensure the anticipated impacts of this action on humpback chub or razorback suckers are not greater than anticipated in the current analyses.

ACTION AREA

The action area is defined as all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). In delineating the action area, we evaluated the farthest reaching physical, chemical, and biotic effects of the action on the environment. The action area for this proposed action included is identical to the one identified in the CFMP and includes all waters from Glen Canyon Dam to Lake Mead National Recreation Area, including the Colorado River and its tributaries in GCNP, and the Glen Canyon reach (Glen Canyon Dam to the Paria River confluence) in GCNRA (see Figure 1; down to approximately RM 277). While there are likely to be continued cooperation of efforts between Lake Mead and GCNP staff that address native and non-native fish issues in the vicinity of their shared boundary, the scope of the Proposed Action is within the boundaries of the Glen Canyon NRA and GCNP as described in the BA and referenced in this BO. Further, staff from the Service, Reclamation, U.S. Geological Survey (USGS), and other NPS units, and contractors coordinate other fish management activities in the action area. Actions taken for humpback chub and razorback sucker by individuals other than NPS staff and NPS contractors, volunteers, or other individuals under NPS control are not covered by this BO. Those agencies and contractors have separate ESA and National Environmental Policy Act (NEPA) compliance and section 10(a)(1)(A) permits from the Service to address their activities. Those activities are included as part of the environmental baseline.

STATUS OF THE SPECIES AND CRITICAL HABITAT

Humpback Chub

The information in this section summarizes the rangewide status of humpback chub that are considered in this BO. Further information on the status of these species can be found in the administrative record for this project, documents on our web page (https://www.fws.gov/southwest/es/arizona/) under Document Library, Document by Species, and in other references cited below.

Humpback chub and critical habitat

The humpback chub, an endemic fish to the Colorado River Basin of the southwestern United States, was listed as endangered on March 11, 1967 (32 FR 4001) and the Service designated critical habitat in 1994 (Service 1994). It is native to the states of Wyoming, Colorado, Utah, and Arizona and there are six recognized populations that occur in mid- and low-elevation, canyon-confined, deep-water regions, including five in the upper basin and one in the lower basin (Lees Ferry is the demarcation line between upper and lower Colorado River basins). The upper basin populations occur in (1) the Colorado River in Cataract Canyon, Utah; (2) the Colorado River in Black Rocks, Colorado; (3) the Colorado River in Westwater Canyon, Utah; (4) the Green River in Desolation and Gray Canyons, Utah; and (5) the Yampa River in Yampa Canyon, Colorado. The only population in the lower basin occurs in the Colorado River in Marble Canyon, the Grand Canyon, and LCR. The numbers of individuals in upper basin populations have varied over time, with the three largest populations most recently supporting 404 and 1,315 adults in Black Rocks and Westwater Canyon in 2012, respectively, and 1,672 adults in Desolation/Gray canyons in 2015. The smallest populations are in Cataract Canyon with 468 adults in 2003 to 295 in 2005 and in Yampa Canyon of the DNM population with 320 adults in 2001 to 224 in 2003. Individuals have not been collected in the DNM population since 2004 and it is therefore considered functionally extirpated (Service 2017).

The lower basin population is found in Marble and Grand canyons, with individuals occupying about 400 km (249 mi) of the mainstem Colorado River from RM 30 to RM 280, as well as about 18 km (11 mi) of the lower LCR and about 6 km (3.7 mi) of lower Havasu Creek. The core population (i.e., LCR population) includes fish from the LCR and fish in an area of about 15 km (9.3 mi) of the mainstem around the LCR confluence that move into the LCR to spawn and mix with resident fish (Kaeding and Zimmerman 1983; Valdez and Ryel 1995; Douglas and Marsh 1996). The LCR population of chub, consists of an adult population (abundance for 2009–2012) of about 11,500–12,000 adults (Yackulic et al. 2014). Annual spawning in the LCR has not been quantified but could contain millions of fish larvae, with approximately 1% reaching the first year of life. Adult and juvenile chub are detected upstream up through the 30-mile reach.

Historically, the humpback chub occurred throughout much of the Colorado River and its larger tributaries from below the Grand Canyon upstream into Arizona, Utah, Colorado, and Wyoming (Service 2002). Historical range and abundance levels are unknown. In 1994, the Service estimated that historical range may have included 2,179 km (1,354 mi) of river (Service 1994), but estimates in 2002 and 2011 have been modified to include only canyon-bound reaches of this previously estimated area, estimating an historic range of approximately 756 km (~470 mi)

(Service 2002, 2011). Current resource conditions in both the upper and lower basin are fair to good, and are mostly adequate to support the species (Service 2018).

Surveys conducted in 2013, 2014, and 2015 suggest that translocated humpback chub have successfully spawned in Havasu Creek (NPS 2013). Humpback chub occupy approximately the lower 5.6 km (3.5 mi) of Havasu Creek, from the mouth to Beaver Falls, which is a barrier to upstream movement of fish. The most recent humpback chub population estimate in Havasu Creek was approximately 297 individuals as of May 2016; with progressively larger cohorts reported by year (NPS pers. comm. 2018). While reproduction and recruitment have been documented in Havasu Creek, the population has increased primarily as a result of continued translocations.

Sampling conducted between October 2013 and September 2014 in western Grand Canyon between Lava Falls (RM 180) and Pearce Ferry (RM 280) captured 144 juvenile humpback chub during sampling of the small-bodied fish community. In addition, 209 humpback chub larvae were collected during sampling of the larval fish community in randomly selected sites (Albrecht et al. 2014). Results were similar in larval and small-bodied fish sampling in 2015, when 285 juvenile and 67 age-0 humpback chub were captured during small-bodied and larval fish sampling, respectively, from throughout the study area (Kegerries et al. 2015). These results suggest that young humpback chub are using widespread nursery and rearing habitats between RM 180 and RM 280 in the western Grand Canyon. In the spring of 2017, evidence of reproduction and recruitment was documented at 30-mile. During this survey, over 90 young fish, of varying size classes were documented by the Service and GCMRC (K. Young pers. comm. 2018; Dodrill pers. comm. 2018).

The LCR aggregation of humpback chub underwent a significant decline in the mid- to late-1990s. This was followed by a period of relatively low, but stable abundance between 2000 and 2006, and by a period (2007–2014) of significantly increased abundance levels (Van Haverbeke et al. 2013). The post-2006 increase in humpback chub ≥150 mm and ≥200 mm was visible during both spring and fall seasons, but it was more apparent during spring months. Spring 2015 monitoring showed significant decrease in abundance of humpback chub ≥150 mm and ≥200 mm compared to the previous several years. The cause of this decline is unknown, but there is evidence from sampling in the mainstem during 2015 that many chub may have simply remained or emigrated into the mainstem during 2015 (i.e., the portion of the LCR aggregation of chub residing in the nearby mainstem was higher than usual).

Humpback chub have expanded in Western Grand Canyon, from near Havasu Creek (RM 158) downstream to below Surprise Canyon (>RM 249). Since 2014, humpback chub in Western Grand Canyon have exhibited annual recruitment and increased catch per unit effort (Van Haverbeke et al. 2017; Rogowski et al. 2018). This expansion has occurred within and outside of the two recognized aggregations (Havasu Creek and Pumpkin Spring) in this area.

In summary, annual abundance estimates suggest that sometime between the early 1990s and 2000, the abundance of humpback chub ≥150 mm underwent a decline in the LCR (Coggins et al. 2008). This decline was followed by a period of relatively low but stable abundance between 2000 and 2006 and then by a post-2006 period of significant increasing trend and has been

relatively stable for about the last five years (Service 2017). A number of factors have been suggested as being responsible for the observed increases, including experimental water releases, trout removal, and drought-induced warming (Andersen 2009; Coggins and Walters 2009). In addition, translocations of juvenile humpback chub to Shinumo and Havasu Creeks have resulted in increased numbers of adult humpback chub captured in the mainstem aggregations (Persons et al. 2017). Translocations to tributaries have been shown to provide an adequate mechanism for rearing juvenile humpback chub that may later disperse to the Colorado River and augment aggregations (Spurgeon et al. 2015).

The humpback chub is a large, long-lived species. This member of the minnow family may attain a length of 20 inches, weigh 2 pounds or more, and live for 20 to 40 years (Andersen 2009). The humpback chub evolved in seasonally warm and turbid water and is highly adapted to the unpredictable hydrologic conditions. Adult humpback chub occupy swift, deep, canyon reaches, but also use eddies and sheltered shoreline habitat (Valdez and Clemmer 1982; Valdez and Ryel 1995; Andersen et al. 2010). Spawning occurs on the descending limb of the spring hydrograph at water temperatures typically between 16 and 22°C. Young require low-velocity shoreline habitats, including eddies and backwaters.

The main spawning area for the humpback chub within the Grand Canyon is the LCR, which provides warm temperatures suitable for spawning and shallow low-velocity pools for larvae (Gorman 1994). This healthy population provides substantial redundancy and representation for the species in the Lower Basin. The species spawns primarily in the lower 13.6 km (8.5 mi) of the LCR, but spawning likely occurs in other areas of the Colorado River as well (Valdez and Masslich 1999; Anderson et al. 2010). Spawning and development of young chub has been documented near 30-mile of the Colorado River through Grand Canyon; where multiple, small, size classes have been documented (Anderson et al. 2010; K. Young pers. comm. 2018; Dodrill pers. comm. 2018) or in other areas in the western Grand Canyon following the detection of larval humpback chub in recent years (Albrecht et al. 2014; Kegerries et al. 2015). Gorman and Stone (1999) found ripe adults aggregated in areas of complex habitat structure associated with clean gravel deposits among large boulders mixed with travertine masses in or near runs and eddies.

Young humpback chub use areas that provide physical cover and contain some velocity refuges, including shoreline talus, vegetation, and backwaters typically formed by eddy return current channels (AGFD 1996; Converse et al. 1998; Dodrill et al. 2015). Backwaters can have warmer water temperatures than other habitats, and native fish, including the humpback chub, are frequently observed in backwaters, leading to a common perception that this habitat is critical for juvenile native fish conservation. However, backwaters are rare and ephemeral habitats, so they contain only a small portion of the overall population. Dodrill et al. (2015) demonstrated the total abundance of juvenile humpback chub was much higher in talus than in backwater habitats, which could be a factor of availability of talus habitats versus backwaters. The Near Shore Ecology project concluded that backwaters are likely not important to the LCR chub aggregation because they are not a significant habitat component in that area (Pine et al. 2013).

As young humpback chub grow, they shift toward deeper and swifter offshore habitats. Valdez and Ryel (1995, 1997) found that young humpback chub remain along shallow shoreline habitats

throughout their first summer, at low water velocities and depths less than 1 m (3.3 ft.). They shift as they grow larger and by fall and winter move into deeper habitat with higher water velocities and depths up to 1.5 m (4.9 ft.). Stone and Gorman (2006) found similar results in the LCR discovering that as humpback chub physically develop their behavior changes from diurnally active, vulnerable, nearshore-reliant, to nocturnally active, large-bodied adults, which primarily reside in deep mid-channel pools during the day and move inshore at night.

The humpback chub is primarily an insectivore, with larvae, juveniles, and adults all feeding on a variety of aquatic insect larvae and adults, including dipterans (primarily chironomids and simuliids), Thysanoptera (thrips), Hymenoptera (ants, wasps, bees), and amphipods (such as *Gammarus lacustris*) in the Colorado River population (Department 2001). Donner (2011) found that 65% of humpback chub production in the Grand Canyon was attributed to abundant food resources including chironomids and simuliids. Feeding by all life stages may occur throughout the water column as well as at the water surface and on the river bottom. Spurgeon et al. (2015) also found that humpback chub consumed native fish, and that they occupied a high trophic position in the food web in a Grand Canyon tributary, similar to rainbow trout.

Primary threats to the species include streamflow regulation and habitat modification (including cold water dam releases and habitat loss), competition with and predation by non-native fish species, parasitism, hybridization with other native *Gila*, and pesticides and pollutants (Service 1990, 2002). Upper basin habitat, including channel geomorphology and water temperature have not changed appreciably, but spring peak flow has been reduced, while summer and winter base flows have increased. Habitat in the Grand Canyon has been modified by the presence and operation of Glen Canyon Dam, including altered flow, temperature regimes, and sediment budget. Predation and competition by non-native fishes is likely the greatest threat to both upper basin and lower basin populations.

Recovery for the humpback chub is defined by the Service Humpback Chub Recovery Goals (Service 2002). The Recovery Goals consist of actions to improve habitat and minimize threats. The success of those actions is measured by the status and trend (i.e., the demographic criteria) of the population. The Service, the Glen Canyon Dam Adaptive Management Program (GCDAMP), and the Upper Colorado River Endangered Fish Recovery Program (UCRRP), are the programs that address conservation of all of the upper Colorado River basin populations of humpback chub, and each uses the underlying science in the Recovery Goals. A 5-Year Review conducted in 2011, relied on the information provided in the recovery goals and provides supplemental information on the species' distribution and status (Service 2011), with an additional 5-year review and recommendation for down listing to threatened in 2018 (Service 2018).

Critical Habitat

Critical habitat for humpback chub was designated in 1994 in seven reaches for a total of 610 km (379 mi) (Service 1994). There are 319 km (198 mi) of critical habitat in the upper basin (Colorado and Utah) and 291 km (181 mi) in the lower basin (Arizona). In Arizona, critical habitat includes 278 km (173 mi) of the Colorado River through Marble and Grand Canyons (Reach 7) from Nautiloid Canyon (RM 34) to Granite Park (RM 208), and the lower 13 km (8

mi) of the LCR (Reach 6). The entire Colorado River reach in Arizona and the bottom portion of the LCR are within the action area for this proposed action.

Critical habitat was designated for the four big river fishes (Colorado pikeminnow [*Ptychocheilus lucius*], humpback chub, bonytail chub [*Gila elegans*], and razorback sucker) concurrently in 1994, and the primary constituent elements (PCEs) were defined for the four species as a group (Service 1994). However, the PCEs vary somewhat for each species on the ground, particularly with regard to physical habitat, because each of the four species has different habitat preferences. The PCEs are:

- Water: Consists of water of sufficient quality (i.e., temperature, dissolved oxygen, lack of contaminants, nutrients, turbidity, etc.) that is delivered in sufficient quantity to a specific location in accordance with a hydrologic regime that is required for the particular life stage for each species.

- Physical Habitat: This includes areas of the Colorado River system that are inhabited by fish or potentially habitable for use in spawning, nursery, feeding, or corridors between these areas. In addition to river channels, these areas include bottomlands, side channels, secondary channels, oxbows, backwaters, and other areas in the 100-year floodplain, which when inundated provide spawning, nursery, feeding, and rearing habitats, or access to these habitats.

- Biological Environment: Food supply, predation, and competition are important elements of the biological environment and are considered components of this constituent element. Food supply is a function of nutrient supply, productivity, and availability to each life stage of the humpback chub. Predation, although considered a normal component of this environment, is out of balance due to introduced fish species in some areas. This is also true of competition from non-native fish species.

The PCEs are all integrally related and must be considered together. For example, the quality and quantity of water affect the food base directly because changes in water chemistry, turbidity, temperature, and flow volume all affect the type and quantity of organisms that can occur in the habitat that are available for food. Likewise, river flows and the river hydrograph have a significant effect on the types of physical habitat available. Changes in flows and sediment loads caused by dams may have affected the quality of nearshore habitats utilized as nursery areas for young humpback chub. Increasingly the most significant PCE seems to be the biological environment, and in particular predation and competition, from non-native species. Even in systems like the Yampa River, where the water and physical PCEs are relatively unaltered, non-native species have had a devastating effect on the ability of that critical habitat unit to support conservation (Finney 2006; Fuller 2009). It is likely that the future conservation of humpback chub may depend on our ability to control non-native species, and manipulating the water and physical PCEs of critical habitat to disadvantage non-natives may play an important role.

Razorback sucker and critical habitat

The razorback sucker was listed as endangered in 1991 (Service 1991). The Razorback Sucker Recovery Plan was released in 1998 (Service 1998) and Recovery Goals were approved in 2002 (Service 2002). Critical habitat for the fish was designated in 1994 (Service 1994).

The species is endemic to large rivers of the Colorado River Basin from Wyoming to Mexico; however, the species range has been substantially reduced (Marsh et al. 2015). The razorback sucker was once abundant in the Colorado River and its major tributaries throughout the basin, occupying 3,500 miles of river in the United States and Mexico (Service 2002, 2018). Records from the late 1800s and early 1900s indicated the species was abundant in the lower Colorado and Gila River drainages (Kirsch 1889; Gilbert and Scofield 1898; Minckley 1983; Bestgen 1990). Within the Grand Canyon, it is likely that razorback suckers historically occurred throughout the Colorado River to Lake Mead (after Hoover Dam construction), with several documented captures in the mainstem (near Bright Angel and Shinumo Creeks), at the Little Colorado River inflow in 1989 and 1990, and from the Paria River mouth (in 1963 and 1978, as reported in NPS 2013). Until recently, the last razorback sucker collected from the Grand Canyon (RM 39.3) was caught in 1993, and the species was considered extirpated from the Grand Canyon. However, in the 2012 and 2013, adult razorback suckers were captured in western Grand Canyon (NPS 2013, GCMRC 2014). In addition, sampling of channel margin habitats has also documented razorback sucker larvae as far upstream as RM 173 (just upstream of Lava Falls) in 2014 (Albrecht et al. 2014) and 2015 (Kegerries et al. 2015), respectively, indicating that spawning is occurring in the mainstem river in the western Grand Canyon (Albrecht et al. 2014; Kegerries et al. 2015). This is the farthest upstream razorback sucker spawning has been documented in the Grand Canyon (Albrecht et al. 2014). The razorback sucker also occurs in the Green River, upper Colorado River, and San Juan River subbasins; the lower Colorado River between Lake Havasu and Davis Dam; Lake Mead and Lake Mohave; and tributaries of the Gila River subbasin (Service 2002; 2018) and Lake Powell (Francis et al. 2015).

Razorback suckers are actively stocked into occupied habitats in the upper and lower basins to prevent extirpation of the species from the wild. The stocking efforts rely on the captive broodstocks in the basins, and the capture of wild-born larvae from Lake Mead and Lake Mohave to provide sub-adult fish for stocking programs. Most populations in the upper Colorado River Basin are maintained by stocking, and in the lower basin, with the exception of Lake Mead, razorback sucker are also maintained through stocking, including populations in Lakes Mohave and Havasu (Marsh et al. 2015). Recruitment has been occurring since the 1970s, sustaining the small population remaining in Lake Mead (Albrecht et al. 2010, Service 2018, Mohn et al. 2015); rangewide, however, recruitment is rare or nonexistent in other populations (Marsh et al. 2015).

The razorback sucker is a large river sucker (Catostomidae) with adults reaching lengths up to 3.3 feet and weigh 11 to 13 pounds (Minckley 1973). Razorback suckers are long-lived, reaching the age of at least the mid-40s (McCarthy and Minckley 1987). Adult razorback suckers use most of the available riverine habitats, although there may be an avoidance of whitewater type habitats. Main channel habitats used tend to be low velocity ones such as pools, eddies,

nearshore runs, and channels associated with sand or gravel bars (Bestgen 1990). Adjacent to the main channel, backwaters, oxbows, sloughs, and flooded bottomlands are also used by this species. From studies conducted in the upper basin, habitat selection by adult razorback suckers changes seasonally. They move into pools and slow eddies from November through April, runs and pools from July through October, runs and backwaters during May, and backwaters, eddies, and flooded gravel pits during June. In early spring, adults move into flooded bottomlands. They use relatively shallow water (approximately three feet) during spring and deeper water (five to six feet) during winter (McAda and Wydoski 1980; Tyus and Karp 1989; Osmundson and Kaeding 1989).

Much of the information on spawning behavior and habitat comes from fishes in reservoirs where observations can readily be made. They typically spawn over mixed cobble and gravel bars on or adjacent to riffles or in shallow shorelines in reservoirs in water 3 to10 feet deep (Minckley et al. 1991). Spawning takes place in the late winter to early summer depending upon local water temperatures. Suitable water temperatures for spawning, egg incubation, and growth range from 14 to 25°C (Service 2002, 2018b), with estimated optimal temperatures of 18°C for spawning, 19°C for egg incubation, and 20°C for growth (Valdez and Speas 2007). Hatching success is temperature dependent, with the potential for complete mortality occurring at temperatures less than 10°C (Service 2002, 2018b).

Habitat needs of larval and juvenile razorback sucker are reasonably well known. Young razorback suckers require nursery areas with quiet, warm, shallow water such as tributary mouths, backwaters, and inundated floodplains along rivers, and coves or shorelines in reservoirs (Service 2002, 2018b). During higher flows, flooded bottomland and tributary mouths may provide these types of habitats.

Razorback suckers are somewhat sedentary; however, considerable movement over a year has been noted in several studies (Service 1998). Spawning migrations have been observed or inferred in several locales (Jordan 1891; Minckley 1973; Osmundson and Kaeding 1989; Bestgen 1990; Tyus and Karp 1990).

Razorback sucker diet varies depending on life stage, habitat, and food availability. Larvae feed mostly on phytoplankton and small zooplankton and, in riverine environments, on midge larvae. Diet of adults taken from riverine habitats consisted chiefly of immature mayflies, caddisflies, and midges, along with algae, detritus, and inorganic material (Service 1998, 2018).

Since the arrival of Euro-Americans in the Southwest, the range and abundance of razorback sucker have been significantly decreased due to water manipulations, habitat degradation, and importation and invasion of non-native species. Construction of dams, reservoirs, and diversions destroyed, altered, and fragmented habitats needed by the sucker. Channel modifications reduced habitat diversity, and degradation of riparian and upland areas altered stream morphology and hydrology. Finally, invasion of these degraded habitats by a host of non-native predacious and competitive species has created a hostile environment for razorback sucker larvae and juveniles. Although the suckers can bring off large spawns each year and produce viable young, in many areas the larvae are largely eaten by non-native fish species (Minckley et al. 1991). The range-wide trend for the razorback sucker is a continued decrease in wild populations due to a lack of

sufficient recruitment due to predation by non-native species on the eggs and larvae and the loss of old adults due to natural mortality.

The UCRRP has implemented considerable research, habitat management, non-native species removal, and stocking actions to benefit the razorback sucker in Colorado, Utah, and Wyoming. The San Juan Program works in the San Juan River in New Mexico and Utah. The Lower Colorado River Multi-Species Conservation Plan (LCR MSCP) is also engaged in research and stocking actions to benefit the razorback in the lower Colorado River of Arizona, California, and Nevada. The razorback sucker is also a covered species in the Bartlett-Horseshoe Habitat Conservation Plan (HCP) on the Verde River, and the Gila River Basin Conservation Program that focuses on impacts from the Central Arizona Project canal.

The 5-year status review for the razorback sucker was completed in 2012 (Service 2012) and the Service is currently in the process of completing an additional 5-year review (Service 2018). The majority of the most meaningful threats to the species, listed in the current recovery plan, have not been mitigated, as only nine of the 29 recovery factor criteria were met.

Critical habitat

As stated above, critical habitat was designated for the four big river fishes (Colorado pikeminnow, humpback chub, bonytail chub, and razorback sucker) concurrently in 1994, and the PCEs were defined for the four species as a group (Service 1994). However, the PCEs vary somewhat for each species on the ground, particularly with regard to physical habitat, because each of the four species has different habitat preferences. The biological support document (Maddux et al. 1993) discusses in depth how each designated reach met the PCEs. The PCEs for razorback sucker are:

- Water: This includes a quantity of water of sufficient quality (i.e., temperature, dissolved oxygen, lack of contaminations, nutrients, turbidity, etc.) that is delivered to a specific location in accordance with a hydrologic regime that is required for the particular life stage.

- Physical habitat: This includes areas of the Colorado River system that are inhabited by razorback suckers or potentially habitable for use in spawning, nursery, feeding, rearing, or corridors between these areas. In addition to river channels, these areas also include bottomlands, side channels, secondary channels, oxbows, backwaters, and other areas in the 100-year floodplain, which, when inundated, provide spawning, nursery, feeding, and rearing habitats.

- Biological environment: Food supply, predation, and competition are important elements of the biological environment and are considered components of this constituent element. Food supply is a function of nutrient supply, productivity, and availability to each life stage of the razorback sucker. Predation, although considered a normal component of this environment, may be out of balance due to introduced fish species in some areas. This may also be true of competition, particularly from non-native fish species.

Critical habitat was designated in 15 river reaches in the historical range of the razorback sucker and includes portions of the Colorado, Duchesne, Green, Gunnison, San Juan, White, and Yampa rivers in the upper basin, and the Colorado, Gila, Salt, and Verde rivers in the lower basin (Service 1994).

Previous Consultations for Humpback Chub and Razorback Sucker

Section 7 consultations on humpback chub and razorback sucker have evaluated large-scale water-management activities. For the upper basin, UCRRP tracks the effects of such consultations on the species and provides conservation measures to offset the effects. Several consultations have occurred on the operations of Glen Canyon Dam, including one in 1995 that resulted in a jeopardy and adverse modification opinion. Subsequent consultations in 2008, 2009, and 2010 reached non-jeopardy/non adverse modification conclusions. The GCNP has consulted on their Comprehensive Fisheries Management Plan (NPS 2013), Exotic Plant Management Plan (2009), and Colorado River Management Plan (2006). Reclamation completed consultation on their *Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead* (2007) and Glen Canyon Dam Long-Term Experimental Management Plan (LTEMP 2016) which focuses on impacts of Dam operations. Specific to razorback sucker in the lower basin, the Lower Colorado River Multi-Species Conservation Program (LCR MSCP) provides for incidental take and conservation of species under section 7(a)(2) and 10(a)(1)(B) for Federal and Non-Federal entities in regards to impacts of water delivery and power generation below Lake Mead. The Service's Wildlife and Sportfish Restoration Program completed a formal consultation on sportfish stocking actions in Lee's Ferry in 2018. Biological opinions on actions potentially affecting humpback chub in Arizona may be found at our website https://www.fws.gov/southwest/es/arizona/ in the Section 7 Biological Opinion page of the Document Library.

ENVIRONMENTAL BASELINE

The environmental baseline includes past and present impacts of all Federal, State, or private actions in the action area, the anticipated impacts of all proposed Federal actions in the action area that have undergone formal or early section 7 consultation, and the impact of State and private actions which are contemporaneous with the consultation process. The environmental baseline defines the current status of the species and its habitat in the action area to provide a platform to assess the effects of the action now under consultation.

Status of the species and potential habitat within the action area

Humpback chub

The Lower Colorado River Basin population of humpback chub is the largest of the six population centers of the humpback chub (Service 2011, 2018) and is found in the Colorado River and LCR (60 mi; 96.6 km) downstream Glen Canyon Dam, with detections of adult and recent spawning and recruitment of young humpback chub occurring 30 miles (48.28 km) downstream of Glen Canyon Dam and Lees Ferry. Within the Grand Canyon, this species is most abundant in the vicinity of the confluence of the Colorado River and LCR (Kaeding and

Zimmerman 1983; Douglas and Marsh 1996 Valdez and Ryel 1995). This population is specifically referred to as the LCR aggregation of humpback chub and includes those fish residing in the LCR and in the mainstem within approximately 15km (9.3 mi) of the LCR mouth. In addition, some of the eight other areas (aggregation areas) where humpback chub are, or have been, regularly collected within the action area. These aggregation areas include the mainstem at 30 Mile, Lava Chuar-Hance, Bright Angel Creek inflow, Shinumo Creek inflow, Stephen Aisle, Middle Granite Gorge, Havasu Creek inflow, and Pumpkin Spring (Valdez and Ryel 1995; Ackerman 2008; Persons et al. 2017). In addition, since 2009, translocations of humpback chub have occurred to introduce juvenile fish into Shinumo and Havasu Creeks, with the goal of establishing additional spawning populations within the Grand Canyon (NPS 2013b) and stocking adults into Bright Angel in 2018. Surveys conducted in 2013, 2014, and 2015 suggest that translocated humpback chub have successfully spawned in Havasu Creek (NPS 2013b). Humpback chub occupy approximately the lower 5.6 km (3.5 mi) of Havasu Creek, from the mouth to Beaver Falls, which is a barrier to upstream movement of fish. Translocations have led to an additional reproducing population in Havasu Creek in Grand Canyon (Service 2017), and they are expanding into western Grand Canyon (Van Haverbeke et al. 2017; Rogowski et al. 2017, 2018). Humpback chub have also been released into Bright Angel Creek, in May of 2018, which followed successful reduction of invasive salmonids in the creek (Healy et al. 2018). An additional adult humpback chub that was initially tagged in the Colorado River was detected on a remote PIT tag antenna in Bright Angel Creek, indicating occasional use of tributaries by adult fish. Approximately 120 humpback chub were reintroduced during the 2018 stocking; however, the current status of chub in Bright Angel is unknown. Annual spawning has been documented in the LCR with young of year moving into the mainstem Colorado River. Sub-adult abundance is stable overall and is not expected to drop below a three-year running average of 1,500 fish during the spring LCR population estimates; in addition the adult population has been stable for the past 5 years, indicating a self-sustaining and possibly growing population (Service 2018).

Sampling conducted between October 2013 and September 2014 in western Grand Canyon between Lava Falls (RM 180) and Pearce Ferry (RM 280) captured 144 juvenile humpback chub during sampling of the small-bodied fish community. In addition, 209 humpback chub larvae were collected during sampling of the larval fish community in randomly selected sites (Albrecht et al. 2014). Results were similar in larval and small-bodied fish sampling in 2015, when 285 juvenile and 67 age-0 humpback chub were captured during small-bodied and larval fish sampling, respectively, from throughout the study area (Kegerries et al. 2015). These results suggest that young humpback chub are using widespread nursery and rearing habitats between RM 180 and RM 280 in the western Grand Canyon.

The LCR aggregation of humpback chub is measured with closed and open population models. Closed models estimate the annual spring and the annual fall abundance of various size classes of chub within the Little Colorado River (Van Haverbeke et al. 2013, 2017). As such, the closed models do not account for chub that are not residing in the LCR during any particular year (i.e., there is always a portion of the LCR aggregation that is residing in the nearby mainstem each year). Initial closed mark-recapture population efforts in the Little Colorado River were conducted in the early 1990s (Douglas and Marsh 1996), after which there was a hiatus until they were resumed again in 2000 (Van Haverbeke et al. 2013, 2017). Results from both of these studies indicate that sometime in the mid- to late-1990s, humpback chub underwent a significant

decline in the LCR. This was followed by a period of relatively low, but stable abundance between 2000 and 2006, and by a period (2007–2014) of significantly increased abundance levels (Van Haverbeke et al. 2013). The post-2006 increase in humpback chub ≥150 mm and ≥200 mm was visible during both spring and fall seasons, but it was more apparent during spring months. Spring 2015 monitoring showed significant decrease in abundance of humpback chub ≥150 mm and ≥200 mm compared to the previous several years. The cause of this decline is unknown, but there is evidence from sampling in the mainstem during 2015 that many chub may have simply remained or emigrated into the mainstem during 2015 (i.e., the portion of the Little Colorado River aggregation of chub residing in the nearby mainstem was higher than usual).

In summary, population estimates indicate that the number of adult humpback chub in Grand Canyon has been increasing since 2000 or 2001 and has been relatively stable for about the last five years. A number of factors have been suggested as being responsible for the observed increases, including experimental water releases, trout removal, and drought-induced warming (Andersen 2009, Coggins and Walters 2009). In addition, translocations of juvenile humpback chub to Shinumo and Havasu creeks have resulted in increased numbers of adult humpback chub captured in the mainstem aggregations (Persons et al. 2017). Translocations to tributaries have been shown to provide an adequate mechanism for rearing juvenile humpback chub that may later disperse to the Colorado River and augment aggregations (Spurgeon et al. 2015).

Critical habitat

Critical habitat for humpback chub in the action area includes a portion of Critical Habitat Reach 6, the LCR, and portions of Critical Habitat Reach 7, the Colorado River in Marble and Grand canyons. Reach 6 consists of the lowermost 8 mi (13 km) of the LCR to its mouth with the Colorado River. Reach 7, consists of a 173-mile (278-km) reach of the Colorado River in Marble and Grand Canyon from Nautiloid Canyon (RM 34) to Granite Park (RM 208).

The current condition of critical habitat in the LCR (Reach 6) is probably similar to historical conditions in many ways. All of the PCEs are provided for in this reach of humpback chub critical habitat, and this segment supports the majority of the Grand Canyon population, the largest of the humpback chub populations.

Critical habitat in Reach 7, in Marble and Grand Canyons, has been altered significantly from historical conditions, primarily due to the construction and operation of Glen Canyon Dam and the presence of non-native aquatic species (Service 2011). The flow of the Colorado River in Marble and Grand canyons has been modified by Glen Canyon Dam since 1964, and the dam and its operation is the primary factor in the function of PCEs in this reach. However, humpback chub use a variety of riverine habitats, with adults found in canyon areas with fast current, deep pools, and boulder habitat, and at least some of the PCEs are functional as demonstrated by the persistence of mainstem aggregations of humpback chub. Reach 7 serves an important role in support of the Grand Canyon population although the relationship with the LCR and the overall importance of habitats in the mainstem to recovery is not well known. This is because most of the humpback chub population occurs in the Little Colorado inflow aggregation, which uses the LCR to a large degree.

Dam discharge and river flow regimes can both destroy and build shoreline rearing habitat, thus affecting juvenile chub survival (Converse et al. 1998). Fluctuating flows can destabilize backwater habitats and may negatively impact aquatic macroinvertebrate production (Kennedy et al. 2016). However, dam releases, such as High Flow Experiments (HFEs), can create shallow backwater habitats associated with sandbars and are thought to provide rearing habitat for native fish, because they may be warmer than the mainstem river water temperature during the summer months due to solar radiation (Behn et al. 2010; Dodrill et al. 2015). Although HFE water releases from Glen Canyon Dam between 2000 and 2008 may have improved some habitat characteristics (e.g., backwaters) for humpback chub, the limited availability of suitable warm water temperatures in the mainstem may have constrained the potential for positive population responses (Kennedy and Ralston 2011). Additional factors affecting the PCEs of critical habitat are discussed below.

The PCEs, as described in the Status of the Species section, are: Water of sufficient quality (i.e., temperature, dissolved oxygen, lack of contaminants, nutrients, turbidity) that is delivered to a specific location in accordance with a hydrologic regime required for the particular life stage for each species; Physical Habitat, areas for use in spawning, nursery, feeding, and movement corridors between these areas; and Biological Environment, food supply, predation, and competition. In summary, the conditions of the PCEs in Reach 7 are:

- The physical PCE for spawning is present within critical habitat Reach 7. During the early 1990s, nine aggregations of humpback chub were described in Grand Canyon (Valdez and Ryel 1995). These comprised the aggregations at 30-Mile, LCR, Lava-Hance, Bright Angel, Shinumo, Stephen's Aisle, Middle Granite Gorge, Havasu, and Pumpkin Spring. Critical habitat has supported additional small aggregations, ranging from 5-98 adult humpback chub per aggregation. Population estimation was not provided for some of the aggregations because of too few recaptured fish (Valdez and Ryel 1995). This trend of low catch in aggregations outside of the LCR aggregation continued during 2002-2006, although the pattern was reported as low relative abundance (catch per unit effort, CPUE) rather than absolute abundance (Ackerman 2008). Since 2010, annual sampling of the aggregations has again resumed. Major findings have been that relative abundances of adult humpback chub in the aggregations have increased since sampling events during the earlier time periods (Persons et al. 2017). Additionally, a group of adult chub likely consisting of between 300-600 individuals has been found near RM-34 in Marble Canyon (Van Haverbeke 2016, pers. comm.), and there appears to have been a dramatic increase in abundances of humpback chub in western Grand Canyon (Havasu Creek and below), with multiple size classes being represented (Van Haverbeke et al. 2017). For example, while the number of adults estimated at the Pumpkin Springs aggregation (~RM 213) was only 5 adult fish during the early 1990s, 69 humpback chub were captured in this aggregation during a single day in 2016; 31 of these being adults. Finally, translocations of humpback chub into Shinumo and Havasu creeks have significantly augmented those respective mainstem aggregations.

- Nursery habitat for juvenile humpback chub may be limited by fluctuating flows that alternately flood and dewater mainstem near shore habitats important to early life stages

of humpback chub and by the loss of sediment-formed habitats. Feeding areas are available to all life stages, especially for adult fish as indicated by condition factor of adult fish in the mainstem compared to those in the LCR (Hoffnagle et al. 2006), although feeding areas in the mainstem may be limiting for juvenile humpback chub due to the effect of fluctuations on nearshore habitats (AGFD 1996). There is evidence of expansion of this population of humpback chub, spawning, survival and growth, upstream near 30-Mile spring (Young Pers. comm. 2018; Dodrill, Pers. comm. 2018).

- Movement corridors appear to be adequate based on movements of humpback chub throughout the system (Valdez and Ryel 1995; Paukert et al. 2006).

- Food supply is a function of nutrient supply, productivity, and availability to each life stage of the humpback chub. River regulation by Glen Canyon dam decreases turbidity in the tail waters (the water immediately downstream of a dam) and permits increased algae growth on bottom substrates (Angradi and Kubly 1994; Shannon et al. 1994), leading to an increased expansion of macroinvertebrate populations in the tail water reach of Glen Canyon Dam (Blinn et al. 1993; Stevens et al. 1997). Algae biomass and production decrease downstream as water clarity decreases (Carothers and Brown 1991; Stevens et al. 1997). This drives a downstream decrease in aquatic invertebrate biomass (e.g., midges, snails, and aquatic worms) (Carothers and Brown 1991; Stevens et al. 1997; Kennedy and Gloss 2005; Rosi-Marshall et al. 2010). Cold water temperatures and daily fluctuations in discharge associated with hydropower production are likely responsible for the low diversity and abundance of aquatic insects downstream of the Paria River (Stevens et al. 1997; Kennedy et al. 2016).

- Non-native fish species that prey on and compete with humpback chub affect the PCEs of the biological environment aspect of critical habitat. Catfish (channel catfish and black bullhead), trout (rainbow and brown trout), and common carp are well established in the action area and will continue to function as predators or competitors of humpback chub. Minckley (1991) hypothesized that non-native fish predation and competition may be the single most important threat to native fishes in Grand Canyon (Valdez and Ryel 1995; Marsh and Douglas 1997; Coggins 2008; Yard et al. 2008). From 2012 to 2018 green sunfish were detected in a slough in the Lees Ferry reach of Glen Canyon and brown trout appear to be fluctuating in this reach as well. Partner agencies treated the slough with various piscicides and/or chemicals annually from 2015-2018 to remove the green sunfish, but it is likely invasions of non-native, predatory fish will continue. Currently, there is evidence that population of brown trout in Lees Ferry is present and fluctuating.

Factors affecting species environment and critical habitat within the action area

Primary factors affecting humpback chub and critical habitat within the action area include habitat alterations associated with dams and reservoirs that have modified water temperature, and the introduction, and expansion, of non-native fishes (Service 2011), which act as competitors and/or predators of the humpback chub (Andersen 2009; Yard et al. 2011; Kennedy et al. 2013).

- Temperatures, particularly in the upper reaches of the action area, even in warmer years, are not optimal for humpback chub spawning and growth. The cold water temperatures in most places of the main channel are below the temperature needed for spawning, egg incubation, and growth of the humpback chub. Survival of humpback chub young in the mainstem near the LCR is thought to be low because of cold mainstem water temperatures (Clarkson and Childs 2000; Robinson and Childs 2001), which may limit hatching success, reduce larval survival and larval and juvenile growth, reduce swimming ability, and increase predation vulnerability (Ward and Bonar 2003; Ward 2011). Water temperatures in the mainstem Colorado River have generally been warmer over the last decade, and warming over the summer increases downstream, due to solar radiation. These warmer water temperatures in the mainstem over the last decade may be providing some temporary benefit and contributing to the improving status of the humpback chub (Reclamation 2011). For example, maximum daily temperatures exceeded 68°F in the lower river (RM 180–RM 280), and daily average temperature was 64°F below the action area in early July (Kegerries et al. 2015). The evidence of recruitment at the 30-mile aggregation possibly due, in part, to the presence of warm springs. Adult chub captured near RM 35, and small size classes of chub found at 30-mile suggests recruitment and possibly an expansion of the 30-mile aggregation.

- Non-native fishes including wild rainbow and brown trout piscivory has been studied in the Lower Colorado River basin, including impacts to humpback chub young. Rainbow trout in the Grand Canyon exhibit slower growth in months when turbidity is high for example with inputs from the Paria and Little Colorado rivers (Yard et al. 2015); smaller rainbow trout are likely due to reduced foraging success (Sweka and Hartman, 2001; Ward et al. 2018). Ward et al. (2018) demonstrated that hatchery reared rainbow trout consumed between 22-47% fewer young chub than wild-born counterparts and that the successful catch of larval chub decreased as turbidity increased under captive research conditions. However, although consumption was lower, the attempt of rainbow trout to forage was still existent, resulting in trout chasing young chub. Although chasing does not always result in a successful catch, it has the potential to result in energy expenditures of larval humpback chub that would not happen unless they were being chased, which could lead to reduced fitness and survival. Additionally, hatchery reared rainbow trout become more efficient over time in this study (Ward 2018). Ingestion of humpback chub eggs by trout has not been studied, but it cannot be ruled out. Yard et al. (2011) documented rainbow and brown trout consume native fish disproportionally to their availability in the Colorado River, in areas where humpback chub aggregations exists. They estimated that a range of 1,232-1,826 humpback chub were consumed each year by wild rainbow trout near the LCR confluence, between 2003 and 2004. Under specific environmental conditions (such as temperature and density of fish) and an increase of rainbow trout abundance from 800 to 1,750 (roughly 46% increase) could lead to a 23% decline in annual survival of humpback chub probability (Yackulic et al. 2018). The Arizona Department of Game and Fish has stocked, and have plans for future stocking of hatchery reared rainbow trout, for which there is likely to be a low level of harassment and predation of humpback chub.

- The incidence of piscivory by brown trout has been found to be much higher than for

rainbow trout in the Grand Canyon (Yard et al. 2011; Whiting et al. 2014), but rainbow trout are much more abundant in the Colorado River, and thus may impact native fish at a similar magnitude or greater (Yard et al. 2011). However, over the past few years the wild population of brown trout in Lees Ferry has increased. Predation by channel catfish, black bullhead, and green sunfish are also thought to impact humpback chub in the Grand Canyon, particularly if warmer water conditions occur (NPS 2013). Because of their size, adult humpback chub are less likely to be preyed on by trout; however, emergent fry, young-of-year (YOY), and juvenile humpback chub are susceptible to predation in the LCR and mainstem Colorado River (Yard et al. 2011). There is evidence of density dependent movement of rainbow trout and a negative relationship of number of rainbow trout and survival and growth of juvenile humpback chub (Yackulic et al. 2018).

In addition, the Colorado River includes non-native fish parasites, such as the Asian tapeworm and anchor worm, which may infect some humpback chub and affect survival (Clarkson et al. 1997; Andersen 2009). Recent studies also indicated that toxic mercury (Hg) and selenium (Se) concentrations in native fish were elevated in the Grand Canyon (Walters et al. 2015). While humpback chub were not tested in the study, elevated levels of Hg in the food web, and in particular, primary prey items, including blackfly larvae (Simuliidae), may result in negative impacts to humpback chub (Walters et al. 2015).

The lower Colorado River, including the action area, has been subject to the effects of Federal, State, and private activities for over 120 years. The greatest changes have come in the last 80 years, with the construction of large dams. Impacts of these human activities along the river have had profound effects on the river, associated riparian and floodplain areas, and the aquatic fauna. The Colorado River below Glen Canyon Dam releases water for a multitude of human uses but primarily for hydropower generation and water delivery. A number of monitoring and research efforts are underway in and throughout the action area as a result of the NPS including their CFMP; and LTEMP, managed by Reclamation, and other biological, cultural, and recreational programs that work in concert to provide management and balance of shared resources. Other meaningful actions are outlined, in previous and ongoing consultation for the Lower Colorado River Basin population of humpback chub including LTEMP (2016), and CFMP (2014). All of these actions take into account their complex impacts to humpback chub and focus on conservation to the species to such a level that it does not jeopardize the species existence. Additional protections and impacts come from actions outlined in the body of documents referred to as the Law of the River, including the Grand Canyon Protection Act. Consideration of native fishes will continue to be a priority and will continue during the life of the proposed action.

Razorback sucker and critical habitat

Status of the species and critical habitat within the action area

Within the Grand Canyon, it is likely that razorback sucker historically occurred throughout the Colorado River to Lake Mead (after Hoover Dam construction), with several documented captures in the mainstem (near Bright Angel and Shinumo Creeks), at the LCR inflow in 1989 and 1990, and from the Paria River mouth (in 1963 and 1978, as reported in NPS 2013). Until

recently, the last razorback sucker collected from the Grand Canyon (RM 39.3) was caught in 1993, and the species was considered extirpated from the Grand Canyon.

Recent efforts to better understand the use of the western Grand Canyon by razorback sucker has revealed that the species is present, but likely rare, in Grand Canyon. Adult razorback suckers have recently been captured from the western Grand Canyon. Four fish that were sonic-tagged in Lake Mead in 2010 and 2011 were detected in the spring and summer of 2012 in GCNP up to Quartermaster Canyon (RM 260) (NPS 2013). An additional untagged adult razorback sucker was captured in GCNP near Spencer Creek (RM 246) in October 2012 (NPS 2013), and another adult was captured in late 2013 (GCMRC 2014). Sampling of channel margin habitats has also documented 462 and 81 razorback sucker larvae as far upstream as RM 173 (just upstream of Lava Falls) in 2014 (Albrecht et al. 2014) and 2015 (Kegerries et al. 2015), respectively, indicating that spawning is occurring in the mainstem river in the western Grand Canyon (Albrecht et al. 2014, Kegerries et al. 2015). Recent captures of larval razorback sucker in western Grand Canyon found the highest density of larvae in isolated pools and backwaters, which comprised less than roughly 2% and 9%, respectively, of all habitat sampled (Albrecht et al. 2014; Kegerries et al. 2015). Larval razorback sucker may drift along the shoreline adjacent to the main channel until settling into warmer, shallow backwaters, or floodplain wetlands (Valdez et al. 2012). This is the farthest upstream razorback sucker spawning has been documented in the Grand Canyon (Albrecht et al. 2014). Unfortunately, small-bodied fish sampling designed to detect juvenile razorback sucker in western Grand Canyon has failed to detect any older larval or juvenile fish. The capture of YOY suckers indicates that there is the potential for razorback sucker spawning in lower Grand Canyon and in-river recruitment (Albrecht et al. 2014). However, based on the presence of larger, older sucker species (i.e., flannelmouth suckers [*Catostomus latipinnis*]) and the lack of predatory non-native fish species in the lower river, it is possible that razorback suckers could (or do) recruit into the action area. There is also evidence that at the Colorado River inflow to Lake Mead, where six razorback suckers, seven razorback sucker x flannelmouth sucker hybrids, and 251 flannelmouth suckers were captured in 2014, hybridization is occurring between razorbacks and flannelmouth suckers. Although the extent and effect of this hybridization on razorback suckers in the lower Grand Canyon is unknown, it may be that with so many flannelmouth and so few razorback sucker adults apparently present (based on capture data), hybridization between the two species is common.

Tagged adult razorback suckers have also been located as far upstream as RM 184.4 near Lava Falls, and along with the collection of larvae, these indicate that the species utilizes the Colorado River above the Lake Mead inflow area more than previously thought (Albrecht et al. 2014). In 2015, submersible ultrasonic receivers (SURs), devices used to detect sonic-tagged razorback suckers, were installed upstream of Lava Falls, to an area below Bright Angel Creek. No detections of razorback sucker were recorded above Lava Falls through September 2015; however, the continued collection of larval fish upstream of Lava Falls indicates spawning is occurring in at least one unknown location in the mainstem or tributaries (Kegerries et al. 2015).

In summary, razorback sucker are located within the project area, from the Colorado River inflow of Lake Mead upstream, as far as an area above Lava Falls in Grand Canyon. The upstream distribution of adult razorback sucker is unknown, but they have been found upstream of Lava Falls. These occurrences since 2013 of adult and larval razorback sucker in Lake Mead

and the lower Grand Canyon downstream of RM 180 indicate that the connectivity of the lake to the riverine reaches may be important to maintenance of razorback sucker in the action area.

Critical habitat

Critical habitat within the action area includes the Colorado River and its 100-year floodplain from the confluence of the Paria River downstream to Hoover Dam (a distance of about 500 mi), including Lake Mead to full pool elevation (Service 1994). Therefore, the entire Colorado River within the action area is razorback sucker critical habitat.

In the riverine portion of the reach (Paria River to Separation Canyon), the PCEs for water, physical habitat, and biological environment have been altered by creation of Glen Canyon Dam as described earlier for the humpback chub. The suitability of the physical habitat conditions for razorback sucker in this reach were likely significantly less even before closure of the dam as razorback suckers are generally not found in whitewater habitats that are home to humpback chub (Bestgen 1990).

Recent warming river temperatures due to lower Lake Powell elevations, attributed to drought and consumptive water use, may have resulted in more suitable habitat in the western Grand Canyon for razorback suckers. In 2015, river temperatures were within the acceptable range needed for razorback sucker spawning and successful hatching, particularly farther downstream (Kegerries et al. 2015). In addition, fish community composition in the lower river below Diamond Creek has changed dramatically from one dominated by non-native species, to native species (Kegerries et al. 2015). However, the cause of the change in fish community composition is unknown. The drop in non-native predator abundance, combined with periodically warmer water temperatures, may have allowed for the expansion of razorback sucker into the western Grand Canyon. Additional research and monitoring are needed to better understand the management implications of these habitat changes for recovery of razorback sucker in Grand Canyon (Albrecht et al. 2014).

Factors affecting species environment and critical habitat within the action area

The historical decline of the razorback sucker and its critical habitat in the Grand Canyon has been attributed primarily to habitat modification due to dam construction (including cold water dam releases, habitat loss, and migration impediments), streamflow regulation, and predation by non-native fish species, which have resulted in a lack of recruitment (Service 2002b, 2018b, Gloss and Coggins 2005).

- Similar to the humpback chub, cold hypolimnetic releases from Glen Canyon Dam have likely contributed to reproductive failure in razorback sucker (Gloss and Coggins 2005). Flow regulation has decreased the magnitude of spring peak runoff, which is closely linked to reproduction of the razorback sucker. The loss or drastic reduction in peak flows, along with channelization or disconnection of floodplain nursery habitats with the main channel (as a result of loss of peak flows), have resulted in the reduction of reproduction and recruitment as it likely occurred historically (Service 2002b, 2018). The flow regimes necessary to maintain razorback sucker populations in the action area,

including flows that provide adequate spawning cues and spawning and nursery habitat, are presumably present as some razorback suckers have been detected in western Grand Canyon and there is evidence of spawning (Albrecht et al. 2014). However, the low numbers of adults detected and lack of recruitment indicate that habitat may not be adequate for suckers to maintain themselves within the action area at this time.

- Competition with and predation by non-native fishes have also been identified as important factors in the decline of the razorback sucker (Minckley et al. 1991, Service 2002b, 2018). The reduced sediment supply and resulting clear water due to dam operations also is thought to favor sight-feeding non-native predators, over razorback sucker and other native fish that evolved in highly turbid conditions (Gloss and Coggins 2005). Studies on the impacts of wild rainbow and brown trout on razorback sucker have not occurred, however, we anticipate that impacts to razorback suckers if present would be similar to humpback chub. Non-native fish attempting to forage may result in harassment and consumption of razorback suckers. Ingestion of razorback sucker eggs and young may occur at locations where detections have occurred. Yard et al. (2011) documented rainbow trout consume native fish disproportionally to their availability in the Colorado River. The Arizona Department of Game and Fish have stocked, and have plans for future stocking of hatchery reared rainbow trout, for with there is likely to be a low level of harassment and predation of humpback chub. The incidence of piscivory by brown trout has been found to be much higher than for rainbow trout in the Grand Canyon (Yard et al. 2011; Whiting et al. 2014). Predation by channel catfish and black bullhead are also thought to impact humpback chub in the Grand Canyon, particularly if warmer water conditions occur (NPS 2013). Because of their size, adult razorback suckers are less likely to be preyed on by trout; however, emergent fry, YOY, and juvenile razorback sucker are susceptible to predation (Yard et al. 2011). Detections of small bodied, young razorback suckers in the lower portion of the action area without evidence of recruitment to adult age in this location may be caused by non-native aquatic species predation.

- Similar to impacts on humpback chub, elevated Hg and Se described by Walters et al. (2015) may be another factor that affects razorback sucker in the Colorado River. While razorback suckers were not tested, other native suckers with similar diets were found to have high levels of Hg and Se in the Grand Canyon (Walters et al. 2015).

EFFECTS OF THE ACTION

Effects of the action refer to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated and interdependent with that action that will be added to the environmental baseline. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. Indirect effects are those that are caused by the proposed action and are later in time, but are still reasonably certain to occur.

Humpback chub and critical habitat

Many of the treatment actions and associated monitoring in the proposed action have potential to have direct impacts to individuals or habitat or by directly and indirectly influencing the abundance and distribution of non-native fish. The majority of negative effects to individual humpback chub are anticipated to be short-term; however, the proposed action is designed to have long-term net population-level benefits for chub through reductions in non-native species which prey on, compete with, and alter habitat of humpback chub.

Targeted Harvest

Incentivized harvest actions (H1) are limited to the Glen Canyon reach where humpback chub historically occurred, but are not currently present. As a result, there is a low probability for anglers to incidentally capture chub in the Glen Canyon reach. NPS would employ CM-12, which is specific to incentivized harvest and includes documenting any new reports of incidental capture, returning any incidental captures to the water immediately, and providing education. Therefore, the anticipated effects of incentivized harvest on humpback chub are insignificant and discountable.

Physical Control

Dewatering of small ponds and backwaters (P1) by portable pumps could have direct effects on humpback chub. This action involves dewatering small non-native breeding and nursery areas by using high-volume pumps for up to two weeks total, and would require first capturing all fish possible by mechanical methods. Should complete desiccation of the area not be possible, then remaining water may be treated with chemical methods. This would result in the removal of any eggs, larvae, or fish remaining in the treatment area. As specified in CM-1 and CM-14, pretreatment surveys will be conducted to relocate any native or endangered species. Additionally, if small fish were missed in the pretreatment surveys, they would likely be caught in the filter screens, or be in the small remaining pools after the pump-out, and could be relocated if still alive. Though there is a low likelihood of harming individual chub during the pump-out process (stranding in water or captured in screens) the possibility is not completely eliminated. Therefore, dewatering of small ponds and backwaters may harm individual humpback chub by stranding, desiccating, or killing with chemicals should chub be present in the treatment area, and therefore may have adverse effects to chub.

The installation of temporary selective weirs (P2) and longer-term non-selective barriers (P3) may have short-term negative effects humpback chub movement and incidental handling. However, long-term impacts are anticipated to be beneficial in that fewer non-native fish will be present in the action area. Impacts from temporary selective weirs will be minimized by CM-6, which dictates the use the “General Guidelines for Handling Fish” (Persons et al. 2013) to minimize injury to non-target fish. Non-selective barriers could potentially affect this species by impeding movement; however, the locations in which this would be used is limited to small backwaters or in tributaries. Implementation of CM-1 and CM-14 will result in pre-treatment surveys and relocation of humpback chub and other non-target species, incidentally captured. The NPS will contact the Service prior to treatment if the area is believed to be occupied and critical for spawning and rearing of chub. These barriers could be in place for a period of time, so

there is the potential for some individual humpback chub to be affected by these barriers but a low chance of incidental take. Though CM-1 and CM14 minimizes the potential to affect chub it is still possible that these activities may create a barrier to movement, therefore, they may have adverse effects to humpback chub.

Small scale temperature change (P5) using a propane heater, would only occur in headwaters of tributary streams such as Bright Angel Creek or smaller areas. An initial small-scale experiment would be conducted prior to implementing this at a larger scale; raising temperatures of water from approximately 15°C to at least 22°C, which may be a critical threshold for YOY brown trout. A target of as high as 29°C, a lethal threshold for adult brown trout (>350 mm total length), would be the maximum attempted temperature target. Initial experiments would target heating a 1,500 ft (457 m) stream segment for up to 6 weeks. Should this small-scale experiment prove successful at eliminating trout (without harming native fishes and aquatic invertebrates), and if heating a larger volume of water is deemed feasible, it could be expanded to treat larger areas and tributaries. Temperature ranges for humpback chub spawning, incubation, and growth are 16°C-22°C and 16°C-27°C, 16°C-22°C, respectively (Valdez and Speas 2007). Temperatures above 35°C are lethal to humpback chub. With (1) CM-1 and CM-14, pre-treatment surveys, relocation of native species, and further discussion with the Service if the treatment area is believed to be occupied and critical for spawning and rearing; (2) because temperature increases likely having beneficial effects to humpback chub; and (3) the temperature range staying under the lethal temperatures for humpback chub, we don't anticipate that this is likely to have a large adversely affect humpback chub. Therefore, the effects of this activity are anticipated to be discountable and insignificant.

Dredging in the 12-Mile Slough (P4) is highly unlikely to affect humpback chub because they have not been documented in the sloughs and currently are not known to occur that far upstream (Service 2017). Pre-treatment surveys would be conducted before the actions per CM-1 and CM-14, and should humpback chub be detected, NPS will contact the Service to discuss options and seek agreement to implement this action. With the implementation of CM-1 and CM-14, we do not anticipate any adverse effects to humpback chub by dredging the 12-Mile Slough area.

Mechanical Control

Any monitoring or removal methods that result in incidental capture and handling of humpback chub could result in harm and increased mortality; CM-6 minimizes, but does not eliminate the chances of this with specific fish handling guidelines. Therefore, there is potential for each of the mechanical removal actions to affect chub. Though there would be a net benefit to the species by removing non-native fish and decreasing their overall number over time. Handling humpback chub that are incidentally captured could result in limited incidental take in the form of harassment and harm (including possible mortality). The result of incidentally handling chub as part of the mechanical removal will likely vary from minor (no physical injury and low stress response) to significant (physical injury or high stress levels that may result in immediate or delayed mortality) depending on the physical fitness of the fish, abiotic environmental conditions, and how the actions are implemented. As described in the proposed action; biological surveys, monitoring and non-native removal in the Colorado River and tributaries in the action area is subject to tagging and handling protocols that are designed to reduce the risk of high

stress or physical injury to individual fish that are captured and handled (Person et al. 2013). These apply to all project elements and some may have additional restrictions not included in those protocols that are part of the CFMP BO or conditions in NPS' section 10(a)(1)(A) permits, which outlines purposeful take not included in this BO.

Mechanical removal using electrofishing and other trapping methods (M2), could be used in any locations within the project area as a method of control to target non-native species. Electrofishing could be used as a monitoring and survey method throughout the project area, so during use of this method NPS personnel could reasonably encounter humpback chub, particularly around the LCR area. This action could potentially lead to some incidental capture and take of individuals in the form of harassment and harm (including mortality). The extent of effects on captured fish rely on sampling gear, size and age class of fish, physical condition of the fish, and environmental conditions under which the fish is captured. Little data exists on the effects of electrofishing on chub; however, occasional mortality has occurred in Grand Canyon due to monitoring. Ruppert and Muth (2011) tested electrofishing and concluded that electrofishing does not affect short-term growth or survival of juvenile humpback chub. However, there is extensive information on capture and handling stress of fish that can be generalized to chub and all methods result in some level of stress to the captured animal, and the results of that stress can vary from species to species and within different lineages of the same species (Cone and Krueger 1988, Hunt 2008). The standard guidelines in fisheries management (Nickum 1988, Schreck and Moyle 1990, Murphy and Willis 1996, and Bonar et al. 2015) were designed around this knowledge to incorporate guidelines that minimize the potential for injury and mortality during survey and monitoring activities. NPS will follow conservation measures CM-5 and CM-6, which include electrofishing and fish handling procedures to minimize incidental harm to natives; however, even with these conservation measures in place it does not completely eliminate the possibility of harming humpback chub. Therefore, the effects from this activity may have an incidental adverse effect on humpback chub.

Passive and active sampling gears, such as nets, will be used as part of this action. Passive nets are those that are set, left, and checked periodically; such as, trammel nets, hoop nets, and minnow traps. Active nets are those that require crews to move them through the water; such as, seines and dip nets. The NPS will use standard methods in the use of these methods which are outlined in the CFMP BO and associated standard practices in fisheries management (Nickum 1988, Schreck and Moyle 1990, Murphy and Willis 1996, Person et al. 2013, and Bonar et al. 2015). Trammel nets can capture larger fish effectively when used properly; however, there is always a level of stress involved that can be fatal in some more sensitive species (Hunt 2008, Hunt et al. 2012, Paukertet al. 2005). Fish can end up injured or dead from the physical trauma or exhaustion while in these nets, especially when set in flowing water such as the Colorado River. Individuals can also be killed if left in these nets too long, and the combined stress of time in the net plus the handling can cause delayed mortality. Current limitations on use of trammel nets based on temperature and time between checking for captured fish are designed to reduce the potential impact on fish captured in the nets. Traps such as hoop nets and minnow traps are less likely to result in physical trauma as the capture is passive and the fish either swim into these traps randomly or are baited into them. Some fish may be captured together with a predatory fish or a larger fish that may begin eating smaller fish within the trap, resulting in mortality of the smaller fish or size classes. Similarly, seines pulled up onto shore may have bunched material

that can harm individuals. With small fish, the act of picking them up out of the seine can cause injury if not done with care. Damage to the mucus coating on a fish's skin can be avoided by having wet hands before handling fish. More active methods of capture include dip nets, hand captures, angling, and seines. These methods are less likely to result in injury or death from being left too long attached to the gear. The act of field crews moving through the water with nets or other equipment also has a risk to eggs or larvae if activities are conducted during the spawning and nursery period for a species. Removing fish from various sampling gear, holding, handling, and release can also result in injury and mortality from physical trauma, secondary infections, and stress (Cho et al. 2011; Francis-Floyd 2009; Harper and Wolf 2009; Portz et al. 2006; Sharpe et al. 1998). Therefore, the effects from netting and handling of fish may have an adverse effect on humpback chub.

Mechanical disruption of early life stage habitat (M1) by use of high-pressure water flushing and mechanical displacement of gravel is a geographically isolated and targeted method. This method is anticipated to displace eggs, larvae and young fish from spawning and nursery locations where non-natives are present. Areas with humpback chub early life stage habitats will not be targeted and therefore, this activity should have a low potential for deleterious effects to humpback chub given that NPS would use CM-14 which includes pre-treatment surveys, relocation of natives, and further discussion with the Service if the treatment area is believed to be occupied by humpback chub and critical for spawning and rearing. Should this method be used in areas where eggs, larvae, of spawning humpback chub are present, this is a risk of disturbing spawning behavior, and killing eggs and larvae. Additionally, this action includes an off-ramp for if potential long-term unacceptable adverse effects on native fish are expected to occur. The limited spatial extent, off-ramp, and CM-14 minimize the potential of adverse effects, but does not completely eliminate the potential for overlap between invasive species early life stage habitat and humpback chub spawning and rearing habitat. Therefore, the effects from mechanical disruption may have an adverse effect on humpback chub individuals.

Activities focusing on acoustic fish deterrent and guidance (M3) are designed to repel fish from target areas and guide them elsewhere. This tool would be deployed to repel non-native fish from suitable breeding habitat, such as warmwater natives from warm backwater habitats where they could reproduce. Acoustic fish deterrents are intended to be non-lethal tools and any incidental mortality of fish should be very low (USACE 2013). These fish deterrents are likely to be non-selective and may also repel humpback chub and prevent their use of target areas; however, the use of sonic guidance would be limited to small backwaters or ponds < 5 ac, many of which are outside of areas occupied by chub. These devices may also require some limited disturbance at the shoreline for installation of generators or solar panels to power the devices. Pre-treatment surveys and relocation would be conducted for humpback chub under CM-1 and CM14 and if chub are present further discussion with the Service would occur to discuss occupancy and if the area is critical for spawning and rearing. These devices could be in place for an extended period of time, so there is the potential for some individual humpback chub to be affected by these barriers by harassment of chub out of the area, but a low chance of incidental take in the form of harm or mortality. The NPS minimizes the potential of take of chub by implementing CM-1 and CM-14; however, there is still the possibility for this activity to affect humpback chub by creating an area of harassment and a barrier to movement, therefore, it may have adverse effects.

Mechanical harvesting of non-native aquatic plants and algae (M4) could be used in small backwater locations (<5ac) and tributaries. Removal of vegetation would include hand removal, rakes, hooks, hand tools, boat rakes, vacuums, underwater weed cutters, nets, shade coverings, covering mats, dyes, or other physical tools for removal. Where feasible, water drawdown and drying may be considered with refilling occurring once the target species are controlled. It is possible for this action to potentially harm, including mortality, individual humpback chub through the physical removal process or water drawdown. Additionally, individual chub may become entrapped in equipment, but most will likely be harassed out of treatment areas if present. With the implementation of CM-14, which includes pre-treatment surveys and further discussion with the Service if the treatment area is believed to be occupied and critical for spawning and rearing, the potential to harm humpback chub should be minimized. Additionally, per CM-14, NPS will avoid conducting actions during spawning season when practicable. However, even with the implementation of CM-14, a drop in oxygen levels or harm to humpback chub during the removal process may occur, therefore this activity may have adverse effects on humpback chub.

Biological Control

Introduction of YY-male brown trout into Glen Canyon (B1) is likely to effect humpback chub downstream starting at RM 30 and down past the confluence of the Colorado and Little Colorado rivers. The analyses in the EA indicated that if the brown trout YY-male stocked fish in Glen Canyon reach have mortality/survivorship, migration and reproduction rates within the bounds of what has been analyzed in the EA, then this tool will reduce the population of predatory non-native brown trout and have a net benefit to the humpback chub population in the long-term, by reducing or eliminating the brown trout population. Wild brown trout live for an average of 5 years with some individuals living in excess of 10 years (NPS 2015), so this effect could occur over a period of years until the YY-males begin to reduce the brown trout population. This analysis was considered over an approximately 10-15 year timeline (anticipating the duration of this action is 20 years). Some stocked YY-male brown trout may migrate and come into contact with individual chub and could lead to incidental take of individuals through competition or predation. However, the expected net effect would be beneficial to humpback chub through the overall reduction in the brown trout population in the long-term. Also, NPS would use the conservation measures for YY-males introductions (CM-13) including PIT tagging or marking introduced YY-males to monitor migration rates, and conditions under which the action would be stopped. The analysis of the estimated level of take in the form of harm (mortality) of humpback chub by brown trout YY-males is found in Appendix B. The effects from this action may have an adverse effect on humpback chub.

The movement and dispersal of various trout species on big rivers has been studied and we use this information in our analysis of estimated out-migration rates for the proposed brown trout stocking. Downstream movement may vary by habitat type (lentic versus lotic systems) and by strain (Moring 1993). Ninety-five percent of the catchable triploid rainbow trout stocked in the Middle Fork of the Boise River, Idaho, was located within 3 km (1.9mi) of the stocking point (High and Meyer 2009). Similar results of movement for catchable trout were reported in Idaho's upper Salmon River, where more than 90% of the reported recaptures were within 3.2 km (2mi) of the stocking site (Bjornn and Mallet 1964), and in the Portneuf

River, where 66% of tagged catchable trout were captured within a few hundred meters of the stocking location (Heimer et al. 1985). Catchable rainbow trout stocked in a tail water fishery moved an average of only 1.4 km (0.9 mi) in July and 3.8 km (2.4 mi) in September within 24 hours after stocking (Bettinger and Bettoli 2002). This lack of dispersal concurs with other studies, where, in general, catchable trout disperse no more than about 1 km (0.62 mi) (Helfrich and Kendall 1982). Some stocked brown trout are expected to move away from stocking locations in a similar manner as these examples. Their behavior in streams shows a combination of long range movements and restricted movements in any given population. Individual fish will also show signs of switching these behaviors (Skurdal et al. 1989). Furthermore, these behavior combinations are presumably adaptive when conditions are often unpredictable and changeable. These movements demonstrate the possibility of trout moving into areas where humpback chub are persisting and spawning, and potentially resulting in disruption of chub spawning behavior or predation on small, larval humpback chub. Predation by brown trout at the LCR confluence has been identified as an additional mortality source affecting chub survival, reproduction, and recruitment (Valdez and Ryel 1995; Marsh and Douglas 1997; Yard et al. 2011; Yackulic 2018). Brown trout are opportunistic feeders and their primary food items depend in part on the life history stage as well as the habitat being used, but includes measurable piscivory (Bachman et al. 1984; Sublette et al. 1990; Valdez and Ryel 1995; Marsh and Douglas 1997; Yard et al. 2011; Yackulic 2018). Sweetser et al. (2002) found brown trout to be the most piscivorous of three trout species (brown, rainbow, and brook [*Salvelinus fontinalis*]) they examined in the LCR in Arizona. Bryan et al. (2000) noted that trout can adversely affect native fish populations through aggressive displacement through interference competition, using resources more quickly and efficiently through exploitative completion, increasing stress hormones, or by opportunistic piscivory.

We evaluate impacts that wild brown trout have on the Grand Canyon population of humpback chub, which is driven by density and movement of trout in the action area (Yackulic 2018). Stocked brown trout movement out of Lees Ferry has not been studied. As conservation measures are employed, managers will be able to detect density dependent movement of stocked brown trout, similar to what has been documented for wild rainbow trout in the Lees Ferry reach. Reduction in trout abundance in the Lees Ferry reach may reduce downstream dispersal into reaches where humpback chub are located (Avery et al. 2015; Yard et al. 2015; Yackulic et al. 2018). Brown trout numbers are currently relatively low but will initially increase with augmented by the proposed action. Another example of density dependent impacts to the Grand Canyon population of humpback chub showed a strong negative relationship between density of brown trout and survival of chub; meaning the higher the density of trout, the lower the numbers of juvenile humpback chub (Yackulic et al. 2018).

The proposed action is to stock 5,000 tagged YY-male brown trout annually into the Glen Canyon reach or into a tributary as a pre-experiment of this method. This number of stocked YY-male brown trout is a large proportion of the overall estimated number of wild brown trout in the Glen Canyon reach. By design, this method relies on swamping the number of wild brown trout by stocking YY-males as a means of skewing the sex ratios of the population.

It is anticipated that predation of humpback chub by stocked YY-male brown trout may result in a moderate to high level of harm in the short-term, but may reduce or eliminate the harm from

wild brown trout in the long-term. Individual humpback chub will experience mortality due to predation of small humpback chub by stocked YY-male brown trout. Impacts to humpback chub are expected to be minor at the stocking site since very few humpback chub persist in the Lees Ferry portion of the river. However, the stocked trout will disperse in the river, increasing the likelihood of competition and predation. We know little about the differences of outmigration rates, or predation rates, of stocked brown trout compared to their wild-born counterparts from Glen Canyon Dam to either the 30-Mile Spring area or down to the confluence with the LCR, therefore we use estimates of movement of the wild rainbow trout from Lees Ferry to areas occupied by humpback chub downstream. Given the wild trout information, we anticipate that some stocked brown trout will move out of the Glen Canyon area either upstream or downstream toward the 30-Mile Spring and LCR confluence area. A model developed by the GCMRC and Service to evaluate the impact of stocking rainbow trout on humpback chub was modified to estimate how stocking YY-male brown trout in the Glen Canyon reach might contribute to mortality of juvenile humpback chub in the LCR reach of the Colorado River (Appendix B). Annual stocking would be limited initially to a maximum of 5,000 adult YY-male brown trout, or an equivalent number of juveniles (estimated to be 10,000 based on assumed juvenile survival rates). This number represents a conservative level of risk to humpback chub if brown trout survival, movement, and predation rates are at high-risk levels. Survival of introduced YY-males would be expected to be lower than that, but the modeling considered a range of survival levels. Modeling indicated that annual stocking of 5,000 adult YY-male brown trout into the Glen Canyon reach for a 10-year period could result in average annual consumption over a 20-year period of 13, 113, and 1,915 juvenile humpback chub under low-, moderate-, and high-risk scenarios, respectively (see Appendix B). Estimated YOY humpback chub production in the Little Colorado River ranges from approximately 5,000 to 45,000 per year (Yackulic 2018), with larval fish being even higher, perhaps as high as millions with only 1% of these surviving the first year (Service 2018). Based on these estimates, stocked brown trout could consume up to 76% of a year's production in some low humpback chub production years and up to 8% of the YOY humpback chub could be consumed in high production years. All efforts will be made to use this technique in years of high productivity for humpback chub and to avoid years when the chub population is below an acceptable threshold. For example, NPS will implement CM 13 which in part ensures that introduction of YY-males is not expected to cause the Tier 1 or Tier 2 trigger conditions in the LTEMP BO to be reached, and if the Tier 1 or Tier 2 trigger have already been reached in a given year or are modeled to be reached in the next year then NPS would not introduce YY-males in that year. Because the tiered triggers of LTEMP are in part based on low humpback chub population estimates and also on the ratio of predatory non-native fish to chub, NPS will avoid stocking when the impacts of the taking are higher, resulting in the predation of 76% of the year's production an unlikely scenario. As part of this action we anticipate a high end estimate of 36 YY male brown trout may accumulate in the LCR reach in any one year, through stocking and movement out of the Glen Canyon Reach. Monitoring efforts (both passive and active) will attempt to document movement and quantify the number of stocked brown trout that move downstream. Brown trout that move downstream may reach areas where humpback spawn in the mainstem or tributaries, resulting in larval humpback chub co-occurring where stocked trout may have dispersed. Nevertheless, given the limited overlap of the

two species, we expect the overall impact to the humpback chub per year to be low in the long-term. Monitoring and conservation measures are in place to evaluate the numbers of stocked trout that leave the Glen Canyon area and reach the LCR confluence and to cease the action if immigration rates are higher than anticipated. Although loss of larval humpback chub is expected, the adult population of humpback chub currently has a population estimate of 12,000 adults and is expected to persist during the life of this project.

Harassment of spawning humpback chub adults by stocked brown trout and some direct predation on small (larval and young of year), and perhaps eggs, of humpback chub is anticipated. Disruption in foraging may also occur, should brown trout harass adults. Additional take in the form of harassment of all life stages of humpback chub, by stocked brown trout, is also expected to occur. This harassment may be in the form of non-lethal harassment of humpback chub by brown trout to such an extent that behavioral modification of avoiding trout might reduce individual humpback chub to shelter, forage, or breed, and could result in decreased fitness of individuals.

Piscivory has been documented by wild brown trout in the Lower Colorado River basin, and in particular for piscivory impacts to humpback chub young (Yard et al. 2011). Although consumption of YOY may be lower with naïve stocked trout, the need to forage will still existent, resulting in trout chasing young chub. Even if chasing does not result in a successful capture, it has the potential to result in energy expenditures of larval humpback chub, which could lead to reduced fitness and survival. Additionally, Ward (2018) found hatchery reared rainbow trout become more efficient at catching prey over time in this study (Ward 2018). Ingestion of humpback chub eggs by trout has not been studied, but it cannot be ruled out as a form of take. Given Yard et al.'s (2011) documented work on trout's disproportionate consumption of native fish in relation to the areas where humpback chub aggregations exists, piscivory is expected to continue with the proposed action.

Because the current population estimate of adult humpback chub is relatively high and stable, this population will likely be able to withstand this experimental action. Additionally, a resilient population of adult humpback chub relies on a larger number of larvae for a population's resiliency and stability. This amount of larval loss should be overcome by compensatory mortality on a system with its current carrying capacity sustaining an adult population of such a large size, as relatively high juvenile mortality is expected for this long-lived fish (Pine et al. 2013). Although predation of small sized humpback chub is anticipated to occur as a result of this stocking, it is not anticipated that it will result in a population level impact, and conservation measures are in place to cease stocking at an early stage if it appears that impacts of the action are greater than anticipated. The conservation measures in the proposed action are designed to protect humpback chub resiliency and support continued efforts towards species conservation and recovery. The Lower Colorado River Basin population of humpback chub is estimated to be abundant (around 12,000 adult individuals) and self-sustaining (Service 2018). Because the current population of adult chub is high and stable, and because the proposed action outlines measures to cease stocking once a conservative number of stocked brown trout have moved into areas where humpback chub are detected, the population level impacts to this humpback chub population is not expected to result in permanent long-term population losses. If the assumed

stocking rate was sufficient for successfully eliminating wild brown trout from the Glen Canyon reach over a 20-year period, the long-term benefits to humpback chub population may outweigh the expected relative short-term adverse effects of the annual losses of juveniles to predation. This control action is considered experimental and updated scientific information, results of field studies, and any other new information regarding effectiveness and negative or unintended impacts of stocking YY-male fish would be reviewed prior to implementation. Additional planning and compliance assessments would be considered if there were significant new information regarding potential impacts.

Chemical Control

Chemical control includes methods such as; overwhelming ecosystem-cycling capabilities (C1; ammonia, oxygen, carbon dioxide, pH, etc.); application of registered piscicides for control of high- and very high-risk non-native species (C2 and C3); and application of registered piscicides for tributary renovation. Each of these activities have reach specific guidance and have Conservation Measures which outline important application and safety methods that are provided to control, avoid, and minimize possible negative effects to the ecosystem, non-target species, and listed species such as humpback chub.

Chemical treatment actions could affect humpback chub individuals and could adversely affect this species and result in low numbers of incidental take. Chemical treatment is only expected in very limited areas in any given year (limited to use in tributary segments with natural barriers, and backwaters and off-channel ponds < 5 ac in size). NPS would not implement overlapping chemical treatment actions in the same location for more than 5 consecutive years. These actions would be a net long-term benefit to humpback populations, as they would reduce populations of non-native species that could compete or predate on humpback chub. A number of conservation measures would be employed in CM-11 to ensure that the chances of effects or incidental take would be minimized. These include pre-treatment surveys and relocation of any humpback chub found in the treatment area, as well as a number of steps to ensure the effect of the chemical treatment is contained in the intended treatment area and neutralized afterwards, if appropriate. However, rotenone, antimycin, or the experimental use of carbon dioxide, oxygen-level alteration, pH alteration or ammonia could have various direct and indirect effects on humpback chub in the treatment area. Direct effects could be from direct exposure to any individual fish to the chemicals in the treatment area, which could be lethal to the fish, or exposure from any spills, though measures in CM-11 should minimize the impacts.

Indirect effects could come from temporary loss of food base in the treatment area. For application of registered piscicides studies have shown that piscicide treatments in streams using rotenone or antimycin had large short-term effects on benthic invertebrate communities but that these communities recovered over time; within one year for antimycin and up to three years for rotenone (Finlayson et al. 2010; Hamilton et al. 2009). Results from rotenone treatments and whole lake experiments indicate that most invertebrate populations will recover after exposure to piscicide concentrations of rotenone (Blakely et al. 2005, Havens 1980). An experiment conducted with a paired set of four wetlands (treated and untreated) found that exposure to rotenone at 300 ppb primarily resulted in only short-term decreases in the abundances of most zooplankton taxa. No significant response was detected in the benthic invertebrate community

and most zooplankton taxa recovered seven months after the exposure to rotenone (Melaas et al. 2001). Vinson et al. (2010) reviewed published laboratory toxicity tests and twenty-two field studies that examined the effects of rotenone on invertebrate communities in lakes, rivers, and streams. They found that zooplankton abundances recovered to pretreatment abundances between one month to three years and that species assemblages can recover within six months of a piscicide treatment. They also found that benthic invertebrate communities in lakes demonstrated similar recovery patterns with recovery times ranging between six months to one year. Application of registered piscides could have adverse effects to humpback chub through harm (including mortality) and short-term reductions in food availability.

Effects from experimental use of carbon dioxide, oxygen manipulation, pH alteration or ammonia addition, should be of similar or shorter duration in effects (compared to rotenone/antimycin) to the benthic invertebrate communities (D. Ward pers. comm. 2018). Therefore, these experimental treatments could have adverse effects to humpback chub through harm (including mortality) and short-term reductions in food availability. However, the effects to food base are expected to be less in duration and extent than piscicide treatments.

Application of registered herbicides and non-toxic dyes to backwaters and off-channel areas would be expected, with the use of conservation measures in CM-15, to have no-effects to humpback chub. Herbicide formulations include inerts, surfactants, and adjuvants, which would be released to water bodies in aquatic applications and particular herbicide formulations and their associated surfactants may vary in their toxicity (Folmar et al. 1979). Those with appropriately low levels of toxicity would be selected through the NPS pesticide approval process and in discussion with the Service for the particular species and treatment area. Neither the active herbicide nor these additives would be expected to have effects on non-target organisms or water quality when used as directed by the manufacturer, and with strict adherence to applicable regulations and guidelines. Treatment of non-native vegetation can lead to a short-term drop in oxygen levels as the vegetation decays (Evans 2008), however some studies have also shown a long-term improvement in dissolved oxygen levels from the removal of non-native aquatic vegetation (Perna and Burrows 2005). This treatment would occur in small backwater areas (<5 acres) or tributaries so any effects would be localized to those areas with a small amount of downstream drift. Under CM-1, pre-treatment surveys would be conducted to assess potential for effects to non-target species, and native species would be relocated or the treatment might be avoided in the specific area or during a specific time period if there was reason to be believe it could effect humpback chub. This action would be expected to provide long-term benefits by removing non-native aquatic vegetation and contributing to the recovery of listed species and conservation of native species and habitats. Though decaying vegetation may result in a drop in oxygen levels, these effects to humpback chub are insignificant and discountable.

Application of mollusk repellents (C6) and non-toxic anti-fouling paints (C5) on boats, equipment used in the river, and NPS water intakes, will be carefully considered by NPS and NPS will ensure that they have also been approved by the state of Arizona. Current repellent treatments include the use of hot pepper capsaicin in a wax-based application. Approved anti-fouling paints for boat and equipment surfaces that do not utilize copper derivatives, which are toxic to aquatic organisms, or other toxic additives will be considered as new options are developed. All use of repellent and anti-fouling paint would be subject to NPS approval

processes in strict adherence to applicable regulations and guidelines. This action is expected to have no effects to humpback chub based on the use of non-toxic repellents as outlined in CM-15.

Humpback chub critical habitat

In our analysis of the effects of the action on critical habitat, we consider whether or not a proposed action would result in the destruction or adverse modification of critical habitat. In doing so, we must determine if the proposed action would result in effects that appreciably diminish the value of critical habitat for the recovery of a listed species. To determine this, we analyze whether the proposed action would adversely modify any of the PCEs that were the basis for determining the habitat to be critical. To determine if an action results in adverse modification of critical habitat, we considered the current condition of all designated critical habitat units for this species, to determine the overall ability of all designated critical habitat to support recovery. Further, the functional role of critical habitat in recovery must also be considered as it represents the best available scientific information as to the recovery needs of the species.

Below, we describe the primary constituent elements or "PCEs" for humpback chub critical habitat that we are evaluating and then briefly describe the "effects" to these PCEs within Reach 6 (Little Colorado River) and Reach 7 (Colorado River from Marble through Grand Canyon) from implementation of this action.

Water Quality/Quantity PCE: This PCE calls for water of sufficient quality (i.e., temperature, dissolved oxygen, lack of contaminants, nutrients, turbidity, etc.) that is delivered in sufficient quantity to a specific location in accordance with a hydrologic regime that is required for each of the life stages of humpback chub. Impacts to this PCE will be short term and minimal. We anticipate that none of the actions will affect water quality, with the exception of chemical treatments for non-native fish and plant removal. However, such treatments will be small in scale and fleeting in time.

Physical Area PCE: This PCE includes the physical areas of the Colorado River system that are inhabited by humpback chub or potentially habitable for use in spawning, nursery, feeding, or corridors between these areas. In addition to the main river channel, this includes bottomlands, side channels, secondary channels, oxbows, backwaters, and other areas in the 100-year floodplain, which when inundated provide spawning, nursery, feeding, and rearing habitats, or access to these habitats. We do not anticipate any physical alternation of habitat in areas where humpback chub are present.

Biological Environment PCE: This PCE includes important elements of the biological environment, food supply, predation, and competition. Food supply is a function of nutrient supply, productivity, and availability to each life stage of the species. Predation and competition (i.e., for food and/or habitat resources) are considered normal components of this environment; but, are likely not at "natural" levels due to the presence of introduced, non-native fish (e.g., brown and rainbow trout) within the action area. Chemical treatments of water may temporarily decrease food supply in small areas, however, we do not think this level of impact will be biologically meaningful to humpback chub, nor will it measurable diminish this PCE.

The introduction of non-native fish species that prey on, and compete with, humpback chub affect one of the PCEs of the biological environment aspect of critical habitat. Non-native fish predation and competition is an important threat to native fishes in Grand Canyon (Minckley 1991, Valdez and Ryel 1995, Marsh and Douglas 1997, Coggins 2008, Yard et al. 2008, Yackulic et al. 2018) including humpback chub. Stocking of non-native brown trout inherently impacts this PCE as outlined under critical habitat for humpback chub. Under the factors listed for the biological environment, areas with no, or low, numbers of non-native fish are preferred. The addition of non-native species, which will prey on and compete with humpback chub, impacts this PCE by definition, consistent with the analysis provided above. However, impacts to all PCEs must be considered collectively when analyzing adverse modification, and impacts to critical habitat.

We do not have evidence that stocking of brown trout will impact any other PCE except for temporarily stocking additional non-native fish that may prey on and compete with humpback chub for food and other resources. One example of this is that stocking of brown trout is not anticipated to impact water quality or quantity. The proposed action is also not likely to significantly alter food resources or the non-natives' fish assemblage presently occurring in the area. However, given the size of the action area, the number of trout proposed to be stocked over the 20-year period, their ability to reproduce, the anticipated estimated level of movement of stocked brown trout into designated critical habitat, and current non-native fish assemblage that is present in the area, we anticipate that proposed stocking of brown trout will not appreciably diminish the conservation value of critical habitat for humpback chub under current environmental conditions.

Additionally, should movement of stocked brown trout be higher than anticipated, monitoring is in place to document this occurrence, and the stocking action will cease, ensuring no unintended impacts or additional impacts to the conservation value of the critical habitat. Finally, other ongoing conservation measures, and a robust research and monitoring plan associated with LTEMP, CFMP, and other efforts are in place, to ensure the conservation of the humpback chub and other native fishes. The proposed action is not expected to further diminish the conservation contribution of critical habitat to the recovery of the humpback chub, because the majority of the PCEs will remain unchanged from baseline, and the current critical habitat in the action area is maintaining a stable population of humpback chub.

Razorback sucker and critical habitat

Many of the treatment actions and associated monitoring in the proposed action have potential to have direct impacts to individuals or habitat or by directly and indirectly influencing the abundance and distribution of non-native fish. The majority of negative effects to individual razorback suckers are anticipated to be short-term; however, the proposed action is designed to have long-term net population-level benefits for the razorback suckers through reductions in non-native species which prey upon, compete with, and alter habitat of suckers. Impacts of the proposed action are anticipated to be similar to humpback chub since there is documentation of razorback suckers being present within the action area. Currently razorback suckers have been primarily found in the Colorado River mainstem in western Grand Canyon (Kegerries et al.

2015), so actions in that area have a higher chance of effecting razorback sucker individuals, however they have the potential for continued expansion throughout the project area and so this section considers the potential, though lower probability, for actions to effect razorback sucker individuals in Marble Canyon or Glen Canyon reach or in the confluence areas of tributaries. We anticipate the level of take of razorback suckers to be less than humpback chub because there are far fewer razorback suckers, to such an extent that we do not have reliable population estimates for these fish within the action area.

Targeted Harvest

Incentivized harvest actions (H1) are limited to the Glen Canyon reach where razorback suckers likely historically occurred, but are not currently present. As a result, there is a low probability for anglers to incidentally capture razorback sucker in the Glen Canyon reach. The NPS would employ CM-12, which is specific to incentivized harvest and includes documenting any new reports of incidental capture, returning any incidental captures immediately to the water, and providing education. Therefore, the anticipated effects of incentivized harvest on razorback sucker are insignificant and discountable.

Physical Control

Dewatering of small ponds and backwaters (P1) by portable pumps could have direct effects to razorback sucker if present. This action involves dewatering small non-native breeding and nursery areas by using high-volume pumps for less than two weeks, and would require first capturing all fish possible by mechanical methods. Should complete desiccation of the area not be possible, then remaining water may be treated with chemical methods outlined in the action. This would result in the removal of any eggs, larvae, or fish remaining in the treatment area. As specified in CM-1 and CM-14, pretreatment surveys will be conducted to relocate any native or endangered species. Additionally, if small fish were missed in the pretreatment surveys, they would likely be caught in the filter screens, or be in the small remaining pools after the pump out, and could be relocated if still alive. Though there is a low likelihood of harming individuals during the pump out process (stranding in water or captured in screens) the possibility is not completely eliminated. Therefore, dewatering of small ponds and backwaters may harm individual razorback sucker by stranding, desiccating, or killing with chemicals should they be present in the treatment area.

The installation of temporary selective weirs (P2) and longer-term non-selective barriers (P3) may have short-term negative effects razorback sucker movement and incidental handling. However, long-term impacts are anticipated to be beneficial in that fewer non-native fish will be present in the action area. Impacts from temporary selective weirs will be minimized by CM-6, which dictates the use the “General Guidelines for Handling Fish” (Persons et al 2013) to minimize injury to non-target fish. Non-selective barriers could potentially affect this species by impeding movement; however, the locations this would be used is limited to small backwaters or in tributaries. Implementation of CM-1 and CM-14 will result in pre-treatment surveys and relocation of razorback sucker and other non-target species, incidentally captured. The NPS will contact the Service prior to treatment if the area is believed to be occupied and critical for spawning and rearing. These barriers could be in place for a period of time, so there is the

potential for some individual razorback sucker to be affected by these barriers but a low chance of incidental take. Though CM-1 and CM14 minimizes the potential to affect razorback sucker it is still possible that these activities may affect suckers by creating a barrier to movement, therefore, they may have adverse effects.

Small scale temperature change (P5) using a propane heater, would only occur in headwaters of tributary streams such as Bright Angel Creek or smaller. An initial small-scale experiment would be conducted prior to implementing this at a larger scale; raising temperatures of water from approximately 15°C to at least 22°C, which may be a critical threshold for YOY brown trout. A target of as high as 29°C, a lethal threshold for adult brown trout (>350 mm total length), would be the maximum attempted temperature target. Initial experiments would target heating a 1,500 ft (457 m) stream segment for up to 6 weeks. Should this small-scale experiment prove successful at eliminating trout (without harming native fishes and aquatic invertebrates), and if heating a larger volume of water is deemed feasible, it could be expanded to treat larger tributaries. Optimal temperature ranges for razorback sucker spawning, incubation, and growth are 14-22°C, 14-25°C, 18-24°C, respectively (Valdez and Speas 2007). This temperature range could be beneficial (in the 22-25°C range to slightly adverse (in the >25-29°C range) in its effects to razorback sucker (Valdez and Speas 2007) while being detrimental to cold water non-natives. With (1) CM-1 and CM-14, pre-treatment surveys, relocation of native species, and further discussion with the Service if the treatment area is believed to be occupied and critical for spawning and rearing; (2) because temperature increases likely having beneficial effects to sucker; and (3) the temperature range staying under the lethal temperatures for razorback sucker, we don't anticipate that this is likely to adversely effects. Therefore, the effects of this activity are anticipated to be discountable and insignificant.

Dredging in the 12-Mile Slough (P4) is highly unlikely to affect razorback sucker because they have not been documented in the sloughs and currently are not known to occur that far upstream (Service 2017). Pre-treatment surveys would be conducted before the actions per CM-1 and CM-14, and should suckers be detected, NPS will contact the Service to discuss options and seek agreement to implement this action. With the implementation of CM-1 and CM-14, we do not anticipate any adverse effects to razorback suckers by dredging the 12-Mile Slough area.

Mechanical Control

Any monitoring or removal methods that result in incidental capture and handling of razorback suckers could result in harm and increased mortality; CM-6 minimizes, but does not eliminate the chances of this with specific fish handling guidelines. Therefore, there is potential for each of the mechanical removal actions to affect suckers. Though there would be a net benefit to the species by removing non-native fish and decreasing their overall number over time. Handling suckers that are incidentally captured could result in limited incidental take in the form of harassment and harm (including possible mortality). The result of incidentally handling razorback suckers as part of the mechanical removal will likely vary from minor (no physical injury and low stress response) to significant (physical injury or high stress levels that may result in immediate or delayed mortality) depending on the physical fitness of the fish, abiotic environmental conditions, and how the actions are implemented. As described in the proposed action; biological surveys, monitoring and non-native removal in the Colorado River and

tributaries in the action area is subject to tagging and handling protocols that are designed to reduce the risk of high stress or physical injury to individual fish that are captured and handled (Person et al. 2013). These apply to all project elements and some may have additional restrictions not included in those protocols that are part of the CFMP BO or conditions in NPS' section 10(a)(1)(A) permits, which outlines purposeful take not included in this BO.

Mechanical removal using electrofishing and other trapping methods (M2), could be used in any locations within the project area as a method of control to target non-native species. Electrofishing could be used as a monitoring and survey method throughout the project area, so during use of this method NPS personnel could encounter razorback suckers. This action could potentially lead to some incidental capture and take of individuals in the form of harassment and harm (including mortality). The extent of effects on captured fish rely on sampling gear, size and age class of fish, physical condition of the fish, and environmental conditions under which the fish is captured. Little data exists on the effects of electrofishing on razorback suckers. However, there is extensive information on capture and handling stress of fish that can be generalized to sucker and all methods result in some level of stress to the captured animal, and the results of that stress can vary from species to species and within different lineages of the same species (Cone and Krueger 1988, Hunt 2008). The standard guidelines in books on fisheries management (Nickum 1988, Schreck and Moyle 1990, Murphy and Willis 1996, and Bonar et al. 2015) were designed around this knowledge to incorporate guidelines that minimize the potential for injury and mortality during survey and monitoring activities. The NPS will follow conservation measures CM-5 and CM-6, which include electrofishing and fish handling procedures to minimize incidental harm to natives; however, even with these conservation measures in place it does not completely eliminate the possibility of harming suckers. Therefore, the effects from this activity may have an incidental adverse effect on razorback sucker.

Passive and active gears, such as nets, will be used as part of this action. Passive nets are those that are set, left, and checked periodically; such as, trammel nets, hoop nets, and minnow traps. Active nets are those that require crews to move them through the water; such as, seines and dip nets. The NPS will use standard methods in the use of these methods which are outlined in the CFMP BO and associated standard practices in fisheries management (Nickum 1988, Schreck and Moyle 1990, Murphy and Willis 1996, Person et al. 2013, and Bonar et al. 2015). Trammel nets can capture larger fish effectively when used properly; however, there is always a level of stress involved that can be fatal in some more sensitive species (Hunt 2008, Hunt et al. 2012, Paukertet al. 2005). Fish can end up injured or dead from the physical trauma or exhaustion while in these nets, especially when set in flowing water such as the Colorado River. Individuals can also be killed if left in these nets too long, and the combined stress of time in the net plus the handling can cause delayed mortality. Current limitations on use of trammel nets based on temperature and time between checking for captured fish are designed to reduce the potential impact on fish captured in the nets. Traps such as hoop nets and minnow traps are less likely to result in physical trauma as the capture is passive and the fish either swim into these traps randomly or are baited into them. Some razorback suckers may be captured together with a predatory fish or a larger fish that may begin eating smaller fish within the trap, resulting in mortality of the smaller fish or size classes. Similarly, seines pulled up onto shore may have bunched material that can harm individuals. With small fish, the act of picking them up out of the seine can cause injury if not done with care. Damage to the mucus coating on a fish's skin

can be avoided by having wet hands before handling fish. More active methods of capture include dip nets, hand captures, angling, and seines. These methods are less likely to result in injury or death from being left too long attached to the gear. The act of field crews moving through the water with nets or other equipment also has a risk to eggs or larvae if activities are conducted during the spawning and nursery period for a species. Removing fish from various sampling gear, holding, handling, and release can also result in injury and mortality from physical trauma, secondary infections, and stress (Cho et al. 2011, Francis-Floyd 2009, Harper and Wolf 2009, Portz et al. 2006, Sharpe et al. 1998). Therefore, the effects from netting and handling of fish may have an adverse effect on razorback sucker.

Mechanical disruption of early life stage habitat (M1) by use of high-pressure water flushing and mechanical displacement of gravel is a geographically isolated and targeted method. This method is anticipated to displace eggs, larvae and young fish from spawning and nursery locations where non-natives are present. Areas with razorback sucker early life stage habitats will not be targeted and therefore, this activity should have a low potential for effects to suckers given that NPS would use CM-14 which includes pre-treatment surveys, relocation of natives, and further discussion with the Service if the treatment area is believed to be occupied by razorback sucker or critical for spawning and rearing. Should this method be used in areas where eggs, larvae, or spawning razorback suckers are present, this is a risk of disturbing spawning behavior, and killing eggs and larvae. Additionally, this action includes an off-ramp for if potential long-term unacceptable adverse effects on native fish are expected to occur. The limited spatial extent, off-ramp, and CM-14 minimize the potential of adverse effects, but does not completely eliminate the potential for overlap between invasive species early life stage habitat and sucker spawning and rearing habitat. Therefore, the effects from mechanical disruption may have an adverse effect on razorback sucker individuals.

Activities focusing on acoustic fish deterrent and guidance (M3) are designed to repel fish from target areas and guide them elsewhere. This tool would be deployed to repel non-native fish from suitable breeding habitat, such as warmwater natives from warm backwater habitats where they could reproduce. Acoustic fish deterrents are intended to be non-lethal tools and any incidental mortality of fish should be very low (USACE 2013). These fish deterrents are likely to be non-selective and may also repel razorback sucker and prevent their use of target areas; however, the use of sonic guidance would be limited to small backwaters or ponds < 5 ac, many of which are outside of areas occupied by razorback sucker. These devices may also require some limited disturbance at the shoreline for installation of generators or solar panels to power the devices. Pre-treatment surveys and relocation would be conducted for humpback chub under CM-1 and CM14 and if chub are present further discussion with the Service would occur to discuss occupancy and if the area is critical for spawning and rearing. These devices could be in place for an extended period of time, so there is the potential for some individual razorback sucker to be affected by these barriers by harassment of razorback suckers out of the area, but a low chance of incidental take in the form of harm or mortality. The NPS minimizes the potential of take of sucker by implementing CM-1 and CM-14; however, there is still the possibility for this activity to creating an area of harassment and a barrier to movement, therefore, it may have adverse effects to razorback sucker.

Mechanical harvesting of non-native aquatic plants and algae (M4) could be used in small backwater locations (<5ac) and tributaries. Removal of vegetation would include hand removal, rakes, hooks, hand tools, boat rakes, vacuums, underwater weed cutters, nets, shade coverings, covering mats, dyes, or other physical tools for removal. Where feasible, water drawdown and drying may be considered with refilling occurring once the target species are controlled. It is possible for this action to potentially harm, including mortality, individual razorback sucker through the physical removal process or water drawdown. Additionally, individual suckers may become entrapped in equipment, but most will likely be harassed out of treatment areas if present. With the implementation of CM-14, which includes pre-treatment surveys and further discussion with the Service if the treatment area is believed to be occupied and critical for spawning and rearing the potential to harm razorback sucker should be minimized. Additionally, per CM-14, NPS will avoid conducting actions during spawning season when practicable. However, even with the implementation of CM-14 a drop in oxygen levels or harm to sucker during the removal process may occur, therefore this activity may have adverse effects on razorback sucker.

Biological Control

Introduction of YY-male brown trout into Glen Canyon (B1) is likely to effect razorback sucker downstream, should these trout move a lengthy amount into areas occupied by suckers. The analyses in the EA indicated that if the brown trout YY-male stocked fish in Glen Canyon reach have mortality/survivorship, migration and reproduction rates within the bounds of what has been analyzed in the EA, then this tool will reduce the population of predatory non-native brown trout and have a net benefit to razorback sucker in the long-term, by reducing or eliminating the brown trout population. Wild brown trout live for an average of 5 years with some individuals living in excess of 10 years (NPS 2015), so this effect could occur over a period of years until the YY-males begin to reduce the brown trout population. This analysis was considered over an approximately 10-15 year timeline (anticipating the duration of this action is 20 years). However, some stocked YY-male brown trout may migrate and come into contact with individual razorback sucker and could lead to incidental take of individuals through competition or predation. However, the net effect would be expected to be beneficial to sucker through the overall reduction in the brown trout population. Also, NPS would use the conservation measures for YY-males introductions (CM-13) including PIT tagging or marking introduced YY-males to monitor migration rates, and conditions under which the action would be stopped. The effects from this action may have an adverse effect on razorback sucker.

Various trout species movement and dispersal on big rivers has been studied and we use this information in our analysis of estimated out-migration rates for the proposed stocking. Some stocked brown trout are expected to move away from areas in which they are stocked and into areas where razorback suckers may be present. Brown trout behavior in streams shows a combination of long range movements and restricted movements in any given population (Skrdal et al. 1989). Individual fish will also show signs of switching these behaviors. Furthermore, these behavior combinations are presumably adaptive when conditions are often unpredictable and changeable. These movements demonstrate the possibility of trout moving into areas where razorback suckers are present and spawning, and potentially resulting in disruption of razorback sucker spawning behavior or predation on small, larval razorback sucker. Predation by brown

trout at the LCR confluence has been identified as an additional mortality source affecting native fish survival, reproduction, and recruitment (Valdez and Ryel 1995, Marsh and Douglas 1997, Yard et al. 2011, Yackulic 2018).

We evaluate impacts that brown trout have on razorback sucker in the Grand Canyon, which is driven by density and movement of rainbow trout in the action area (Yackulic 2018). Stocked brown trout movement out of Lees Ferry has not been studied. As conservation measures are employed, managers will be able to detect density dependent movement of stocked brown trout, similar to what has been documented for wild brown trout in the Lees Ferry reach. Reduction in trout abundance in the Lees Ferry reach may reduce downstream dispersal into reaches where razorback suckers may be present (Avery et al. 2015, Yard et al. 2015, Yackulic et al. 2018). Brown trout numbers are currently relatively low but will initially increase with augmented by the proposed action.

It is anticipated that predation of razorback sucker by stocked YY-male brown trout may result in a moderate to high level of harm in the short-term, but may reduce or eliminate the harm from wild brown trout in the long-term. Individual razorback sucker will experience mortality due to predation by stocked YY-male brown trout. Impacts to suckers are expected to be minor at the stocking site since very few razorback suckers have been recently documented in upper portion of the river. However, the stocked trout will disperse in the river, increasing the likelihood of competition and predation the farther downstream they move. We know little about the differences of outmigration rates, or predation rates, of stocked brown trout compared to their wild-born counterparts from Lees Ferry. For humpback chub, we were able to estimate the level of expected predation by brown trout; however, we do not have population analyses for razorback sucker, and therefore cannot give an estimate of take. Razorback suckers that are detected in the action area are most likely at the upper end of the Lake Mead population, that move up into Grand Canyon, and few in number. Consistent with the humpback chub analyses of this action we anticipate that a high end estimate of 36 stocked YY male brown trout will accumulate in the LCR reach, with the number declining farther downstream. It is not known how many trout move out of the Glen Canyon Reach but low movement rates measured at the LCR reach coupled with mortality of stocked fish limit the number present in any one year or reach.

Harassment of spawning razorback sucker adults by stocked brown trout and some direct predation on small (larval and young of year), and perhaps eggs, of razorback sucker is anticipated. Disruption in foraging may also occur, should brown trout harass adults. Additional take in the form of harassment of all life stages of razorback sucker, by stocked brown trout, is also expected to occur. This harassment may be in the form of non-lethal harassment of razorback sucker by brown trout to such an extent that behavioral modification of avoiding brown trout might reduce individual razorback sucker's ability to shelter, forage, or breed, and could result in decreased fitness of individuals.

Piscivory has been documented by wild brown trout in the Lower Colorado River basin. Although consumption of YOY may be lower with naïve stocked trout, the need to forage will still existent, resulting in trout chasing young razorback sucker. Even if chasing does not result in a successful capture, it has the potential to result in energy expenditures of larval suckers, which

could lead to reduced fitness and survival. Additionally, Ward (2018) found hatchery reared rainbow trout become more efficient at catching prey over time in this study (Ward 2018). Ingestion of razorback sucker eggs by trout has not been studied, but it cannot be ruled out as a potential form of take. Given Yard et al.'s (2011) documented work on rainbow trout's disproportionate consumption of native fish, piscivory is expected to continue with the proposed action.

The current population estimate of razorback suckers in the action area is not possible, likely because numbers are so low. Additionally, a resilient population of adult razorback sucker relies on a larger number of larvae for population's resiliency and stability, which may be present in Lake Mead, but is not currently thought to exist upstream in the Grand Canyon. Although predation of small sized razorback sucker is anticipated to occur as a result of this stocking, it is not anticipated that it will result in a population level impact to the Lake Mead population, and conservation measures are in place to cease stocking at an early stage if it appears that impacts of the action are greater than anticipated. The conservation measures in the proposed action are designed to promote razorback sucker resiliency and support continued efforts towards species conservation and recovery. This control action is considered experimental and updated scientific information, results of field studies, and any other new information regarding effectiveness and negative or unintended impacts of stocking YY-male fish would be reviewed prior to implementation. Additional planning and compliance assessments would be considered if there were new information regarding potential impacts.

Chemical Control

Chemical control includes methods such as; overwhelming ecosystem-cycling capabilities (C1; ammonia, oxygen, carbon dioxide, pH, etc.); application of registered piscicides for control of high- and very high-risk non-native species (C2 and C3); and application of registered piscicides for tributary renovation.. Each of these activities have reach specific guidance and have Conservation Measures which outline important application and safety methods that are provided to control, avoid, and minimize possible negative effects to the ecosystem, non-target species, and listed species such as razorback sucker.

Chemical treatment actions could affect razorback sucker individuals and could adversely affect this species and result in low numbers of incidental take. Chemical treatment is only expected in very limited areas in any given year (limited to use in tributary segments with natural barriers, and backwaters and off-channel ponds < 5 ac in size). NPS would not implement overlapping chemical treatment actions in the same location for more than 5 consecutive years. These actions would be a net long-term benefit to razorback sucker as they would reduce populations of non-native species that could compete or predate on razorback sucker. A number of conservation measures would be employed in CM-11 to ensure that the chances of effects or incidental take would be minimized. These include pre-treatment surveys and relocation of any razorback sucker found in the treatment area, as well as a number of steps to ensure the effect of the chemical treatment is contained in the intended treatment area and neutralized afterwards, if appropriate. However, rotenone, antimycin, or the experimental use of carbon dioxide, oxygen-level alteration, pH alteration or ammonia could have various direct and indirect effects on razorback sucker in the treatment area. Direct effects could be from direct exposure to any

individual fish to the chemicals in the treatment area, which could be lethal to the fish, or exposure from any spills, though measures in CM-11 should minimize the chances of that.

Indirect effects could come from temporary loss of food base in the treatment area. For application of registered piscicides studies have shown that piscicide treatments in streams using rotenone or antimycin had large short-term effects on benthic invertebrate communities but that these communities recovered over time; within one year for antimycin and up to three years for rotenone (Finlayson et al. 2010, Hamilton et al. 2009). Results from rotenone treatments and whole lake experiments indicate that most invertebrate populations will recover after exposure to piscicide concentrations of rotenone (Blakely et al. 2005, Havens 1980). Application of registered piscides could have adverse effects to razorback sucker through harm (including mortality) and short-term reductions in food availability.

Effects from experimental use of carbon dioxide, oxygen manipulation, pH alteration or ammonia addition, should be of similar or shorter duration in effects (compared to rotenone/antimycin) to the benthic invertebrate communities (D. Ward pers. comm. 2018). Therefore, these experimental treatments could have adverse effects to razorback sucker through harm (including mortality) and short-term reductions in food availability. However, the effects to food base are expected to be less in duration and extent than piscicide treatments.

Application of registered herbicides and non-toxic dyes to backwaters and off-channel areas would be expected, with the use of conservation measures in CM-15, to have no-effects to razorback sucker. Herbicide formulations include inerts, surfactants, and adjuvants, which would be released to water bodies in aquatic applications and particular herbicide formulations and their associated surfactants may vary in their toxicity (Folmar et al. 1979). Those with appropriately low levels of toxicity would be selected through the NPS pesticide approval process and in discussion with the Service for the particular species and treatment area. Neither the active herbicide nor these additives would be expected to have effects on non-target organisms or water quality when used as directed by the manufacturer, and with strict adherence to applicable regulations and guidelines. Treatment of non-native vegetation can lead to a short-term drop in oxygen levels as the vegetation decays (Evans 2008), however some studies have also shown a long-term improvement in dissolved oxygen levels from the removal of non-native aquatic vegetation (Perna and Burrows 2005). This treatment would occur in small backwater areas (<5 acres) or tributaries so any effects would be localized to those areas with a small amount of downstream drift. Under CM-1, pre-treatment surveys would be conducted to assess potential for effects to non-target species, and native species would be either be relocated or the treatment might be avoided in the specific area or during a specific time period if there was reason to be believe it could effect razorback sucker. This action would be expected to provide long-term benefits by removing non-native aquatic vegetation and contributing to the recovery of listed species and conservation of native species and habitats. Though decaying vegetation may result in a drop in oxygen levels, these effects to razorback sucker are insignificant and discountable.

Application of mollusk repellents (C6) and non-toxic anti-fouling paints (C5) on boats, equipment used in the river, and NPS water intakes, will be carefully considered by NPS and NPS will ensure that they have also been approved by the state of Arizona. Current repellent treatments include the use of hot pepper capsaicin in a wax-based application. Approved anti-

fouling paints for boat and equipment surfaces that do not utilize copper derivatives, which are toxic to aquatic organisms, or other toxic additives will be considered as new options are developed. All use of repellent and anti-fouling paint would be subject to NPS approval processes in strict adherence to applicable regulations and guidelines. This action is expected to have no effects to razorback sucker based on the use of non-toxic repellents as outlined in CM-15.

Razorback sucker critical habitat

In our analysis of the effects of the action on critical habitat, we consider whether or not a proposed action would result in the destruction or adverse modification of critical habitat. In doing so, we must determine if the proposed action would result in effects that appreciably diminish the value of critical habitat for the recovery of a listed species. To determine this, we analyze whether the proposed action would adversely modify any of the PCEs that were the basis for determining the habitat to be critical. To determine if an action results in adverse modification of critical habitat, we considered the current condition of all designated critical habitat units for this species, to determine the overall ability of all designated critical habitat to support recovery. Further, the functional role of critical habitat in recovery must also be considered as it represents the best available scientific information as to the recovery needs of the species.

Below, we describe the primary constituent elements or "PCEs" for razorback sucker critical habitat that we are evaluating and then briefly describe the "effects" to these PCEs within the action area.

Water Quality/Quantity PCE: This PCE calls for water of sufficient quality (i.e., temperature, dissolved oxygen, lack of contaminants, nutrients, turbidity, etc.) that is delivered in sufficient quantity to a specific location in accordance with a hydrologic regime that is required for each of the life stages of humpback chub. Impacts to this PCE will be short term and minimal. We anticipate that none of the actions will effect water quality, with the exception of chemical treatments for non-native fish and plant removal. However, such treatments will be small in scale and fleeting in time.

Physical Area PCE: This PCE includes the physical areas of the Colorado River system that are inhabited by humpback chub or potentially habitable for use in spawning, nursery, feeding, or corridors between these areas. In addition to the main river channel, this includes bottomlands, side channels, secondary channels, oxbows, backwaters, and other areas in the 100-year floodplain, which when inundated provide spawning, nursery, feeding, and rearing habitats, or access to these habitats. We do not anticipate any physical alternation of habitat in areas where razorback sucker are present.

Biological Environment PCE: This PCE includes important elements of the biological environment, food supply, predation, and competition. Food supply is a function of nutrient supply, productivity, and availability to each life stage of the species. Predation and competition (i.e., for food and/or habitat resources) are considered normal components of this environment; but, are likely not at "natural" levels due to the presence of introduced, non-native fish (e.g.,

brown and rainbow trout) within the action area. Chemical treatments of water may temporarily decrease food supply in small areas, however, we do not think this level of impact will be biologically meaningful to razorback sucker, nor will it measurable diminish this PCE.

The introduction of non-native fish species that prey on and compete with razorback sucker affect one of the PCEs of the biological environment aspect of critical habitat. Non-native fish predation and competition is an important threat to native fishes in Grand Canyon (Minckley 1991, Valdez and Ryel 1995, Marsh and Douglas 1997, Coggins 2008, Yard et al. 2008, Yackulic et al. 2018). Stocking of non-native brown trout inherently impacts this PCE as outlined under critical habitat for razorback sucker. Under the factors listed for the biological environment, areas with no, or low numbers of non-native fish are preferred. The addition of non-native species, which will prey on and compete with razorback sucker, impacts this PCE by definition, consistent with the analysis provided above. However, impacts to all PCEs must be considered collectively when analyzing adverse modification, and impacts to critical habitat.

We do not have evidence that stocking of brown trout will impact any other PCE except for putting additional non-native fish that may prey on and compete with razorback sucker for resources. One example of this is that stocking of brown trout is not anticipated to impact water quality or quantity. The proposed action is also not likely to significantly alter food resources or the non-natives' fish assemblage presently occurring in the area. However, given the size of the action area, the number of trout proposed to be stocked over the 20-year period, their ability to reproduce, the anticipated estimated level of movement of stocked brown trout into designated critical habitat, and current non-native fish assemblage that is present in the area, we anticipate that proposed stocking of brown trout will not appreciably diminish the conservation value of critical habitat for razorback sucker under current environmental conditions.

Additionally, should movement of stocked brown trout be higher than anticipated, monitoring is in place to document this occurrence, and the stocking action will cease, ensuring no unintended impacts or additional impacts to the conservation value of the critical habitat. Finally, other ongoing conservation measures, and a robust research and monitoring plan associated with LTEMP, CFMP, and other efforts are in place, to ensure the conservation of the razorback sucker and other native fishes. The proposed action is not expected to further diminish the conservation contribution of critical habitat to the recovery of the razorback sucker because the majority of the PCEs will remain unchanged from baseline, and the current critical habitat in the action area is maintaining small numbers of razorback suckers.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this BO. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

This portion of the river is managed by NPS, Reclamation, and Tribal partners, requiring Federal permits or authorization, which would be subject to Section 7 consultation. Below is a summary of future non-federal activities that are reasonably likely to occur within the action area that directly and indirectly affect species/critical habitat addressed in this assessment. These are added to the environmental baseline (discussed above).

Uranium mining peaked in the 1980s in the Grand Canyon region, but there is now a renewed interest due to increases in uranium prices. Increased uranium mining (on state and private lands) could increase the amount of uranium, arsenic, and other trace elements in local surface water and groundwater flowing into the Colorado River (Alpine 2010). Uranium, other radionuclides, and metals associated with uranium mines can affect the survival, growth, and reproduction of aquatic biota. Aquatic biota and habitats most likely to be affected during mine development and operation are those associated with small, ephemeral, or intermittent drainages. Impacts on aquatic biota and habitats from the accidental release of regulated or hazardous materials into ephemeral drainages would be localized and small, especially if a rapid response to a release is undertaken. However, the potential for such an event is extremely low. For these reasons, the impacts from uranium mining on aquatic biota in the Colorado River or its major tributaries would be localized and may not reduce the viability of affected resources. It is anticipated that any impacts on wildlife from uranium mining would be localized and should not affect the viability of affected resources, especially with the use of best management practices to control mine discharges and proper mine reclamation.

As the population in the Colorado River basin states grows and expands, municipal, industrial, and agricultural water demand continues to increase. A Reclamation study in 2012 showed that the demand for Colorado River basin water may exceed demand before 2060 (Reclamation 2012), which may result in lower Lake Powell levels and changes in flow, sediment, and water temperature regimes in Grand Canyon. Meeting increasing water needs will likely lead to lower reservoir levels in Lake Powell, which may already be affected by increased evaporation associated with higher air temperatures. The decreasing elevation of Lake Powell can lead to warmer water discharges from Glen Canyon Dam and increased water temperatures downstream into Glen and Grand Canyons. This could increase the likelihood of establishment of more warmwater non-native predators and have several other effects described below. This includes fish parasites such as the Asian tapeworm, anchor worm, and non-native crayfish. Increased zooplankton due to climate change may increase abundance of cyclopoid copepods. All cyclopoid copepod species appear to be susceptible to infection by, and therefore serve as intermediate hosts for, the Asian tapeworm (Marcogliese and Esch 1989). Crayfish can prey on fish eggs and larvae and can diminish the abundance and structure of aquatic vegetation such as filamentous algae through grazing (Service 2011). Higher temperatures in the Colorado River Basin have resulted in less precipitation falling and being stored as snow at high elevations in the Upper Basin (the main source of runoff to the river), increased evaporative losses, and a shift in the timing of peak spring snowmelt (and high streamflow) to earlier in the year (NAS 2007; Christensen et al. 2004; Jacobs 2011). These effects in turn have exacerbated competition among users (farmers, energy producers, urban dwellers), as well as effects on ecological systems, during a time when due to a rapidly rising population water demand has never been higher (Garfin et al. 2014). The combination of decreasing supply and increasing demand will present a challenge in meeting the water delivery commitments outlined in the Colorado River Compact of

1922 (apportioning water between the Upper and Lower Basins) and the United States–Mexico Treaty of 1944 (which guarantees an annual flow of at least 1.5 million ac-ft to Mexico). In 2007, DOI adopted interim guidelines (Reclamation 2007) to specify modifications to the apportionments to the Lower Basin states in the event of water shortage conditions. An additional Drought Contingency Plan is being finalized to address falling water elevations of Lake Mead and the result of such a plan could result in additional modifications to the overall system.

Local development projects, such as proposed in the town of Tusayan, Arizona, could impact humpback chub habitat by withdrawing water from the same aquifer that is the basis for streamflow in Havasu Creek, however the true extent of water withdrawals and their effects on Havasu Creek baseflow are unknown. In future years, the adaptive management framework for humpback chub translocations to Havasu Creek will allow for changes in management strategies in the case that streamflows are reduced to a point that the project is not viable, which is unlikely. Population and industrial growth, coupled with climate change, will act in concert to increase water demand in the region (Schindler 2001) and lower flows downstream of Glen Canyon Dam. This could stress existing riparian and wetland vegetation, leading to plant community alterations that would affect both wildlife habitats and the wildlife prey base. Climate change would not affect all wildlife species uniformly. Some species would experience distribution contractions and likely shrinking populations while other species would increase in suitable areas and thus possibly experience increases in population numbers. Generally, the warmer the current range is for a species, the greater the projected distributional increase (or lower the projected loss) will be for that species due to climate change (van Riper et al. 2014). Increased climate warming may increase the spread and establishment of some non-native aquatic species into this geographic area.

Urban runoff, industrial releases, and municipal discharges are considered some of the leading nonpoint sources of contaminants to surface waters (USEPA 2004). Areas of intensive agriculture can have an adverse effect on the water quality as a result of the salinity, nutrients, pesticides, selenium, and other trace elements that are common constituents in agricultural runoff. For example, elevated selenium found in aquatic organisms in Colorado River in Grand Canyon is thought to be partly due to agricultural runoff from areas with soils containing selenium (Walters et al. 2015). It is unclear how contamination due to agricultural and urban discharge may change into the future.

The Navajo Nation has proposed a 420-ac development project, known as the Grand Canyon Escalade, on the Grand Canyon's eastern rim on the western edge of the Navajo reservation at the confluence of the Little Colorado and Colorado rivers. The development would include a 1.4-mi-long, eight-person tramway (gondola) to transport visitors 3,200 ft from the rim to the canyon floor. Analysis for this project has not been conducted, so impacts have not been fully determined; however, the construction and operation of the Escalade project could result in adverse impacts on natural and cultural resources in the areas of the LCR confluence, wilderness, visual resources, and resources of importance to multiple Tribes. The LCR contains critical spawning habitat for humpback chub. The Grand Canyon Escalade Project and its associated facilities near the confluence of the LCR could cause both a localized loss of wildlife habitat and source of wildlife disturbance due to human presence.

The incremental effects of the proposed action on the listed species addressed in this biological assessment are not expected to contribute significantly to cumulative impacts along the Colorado River corridor or within the basin at large. The larger cumulative effects to humpback chub and razorback sucker expected to occur are from increased municipal and agricultural demand coupled with climate change resulting in less, and warmer, water and the related effects. This proposed action in expected to have net positive effects to humpback chub and razorback sucker from controlling non-native species, and is not expected to add any net negative cumulative impacts for these species.

CONCLUSION

After reviewing the current status of the humpback chub and razorback sucker, the environmental baseline for the action area, the effects of the action, and the cumulative effects, it is our opinion that the NPS NNAS plan is not likely to jeopardize the continued existence of humpback chub and razorback sucker, nor result in adverse modification of associated critical habitat. A number of individual humpback chub and razorback sucker, of all life stages, will be displaced or preyed on by introduced YY-male fish. Additionally, harassment of adults or harm of young chub by stocked YY-male fish species could occur. Additional handling and harm may come from all other removal actions, but the impacts of this taking are anticipated to be minimal. Fish community structure disruption is not anticipated to result in population level impacts to the humpback chub or razorback sucker in this area for the overall Proposed Action. Individual humpback chub and razorback sucker will be taken but not to such an estimated level that long-term population level impacts will result. Taking of humpback chub and razorback sucker will be a small number compared to the current estimated stable population's level.

INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined (50 CFR 17.3) to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. "Harass" is defined (50 CFR 17.3) as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. "Incidental take" is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the Action Agencies so that they become binding conditions of any grant or permit issued, as appropriate, for the exemption in section 7(a)(2) to apply. The Action Agencies have a continuing duty to

regulate the activity covered by this incidental take statement. If the Action Agency (1) fails to assume and implement the terms and conditions or (2) fails to require any applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(a)(2) may lapse. In order to monitor the impact of incidental take, the Action Agencies must report the progress of the action and its impact on the species to the Service (AESO) as specified in the incidental take statement. [50 CFR §402.14(i) (3)].

AMOUNT OR EXTENT OF TAKE

Targeted Harvest

Incentivized harvest actions are limited to the Glen Canyon reach where humpback chub and razorback sucker are not currently present. As a result, there is a low probability for anglers to incidentally capture chub or sucker and the anticipated effects of incentivized harvest on humpback chub are insignificant and discountable. As such we do not provide an estimate of incidental take for this activity.

Physical Control

Physical controls include methods such as; dewatering relatively small ponds and backwater areas by high-volume portable pumps for short time periods, placement of selective weirs to disrupt spawning or new invasions, placement of non-selective barriers to restrict access to tributaries, backwaters, and off-channel habitat areas, produce small scale temperature changes using a propane heater to adversely affect coldwater non-native fish, and dredging of one identified small pond at RM-12 in GCNRA. Despite the provisions for safe capture, transport, holding, and release of humpback chub and razorback sucker from the treatment areas, there is always a risk of mortality when handling fish in these situations. Incidental take from monitoring, handling and salvage efforts is addressed below. Further, if present, it is unlikely that all humpback chub and razorback sucker will be removed by the salvage operation, and any individuals remaining in the treatment area will die due to the effects of entrapment in pumps and areas that are dewatered, or by restricting movement by weirs. Incidental take of humpback chub and razorback sucker is reasonably certain to occur as a result of the proposed physical control methods in the action area. Incidental take will result in the form of harm if fish die, and harassment should fish be restricted from areas which they were using for feeding, breeding, or sheltering.

The Service anticipates incidental take of humpback chub and razorback sucker will be difficult to detect for the following reasons: detection of a dead or impaired individual fish is unlikely as bodies disappear quickly as they are carried downstream, sink to the creek bottom, or are eaten by birds and mammals, and quantifying a minimal amount of interference in movement is difficult. Although we cannot estimate the number of individual fish that will be incidentally taken during these actions we anticipate the number of humpback chub and razorback sucker taken in such a way will be minimal because NPS will employ conservation measures that will oftentimes avoid areas that are occupied by chub or suckers. Incidental take during salvage, or as a result of the physical control activity itself should not rise above the level of take of mechanical

removal and handling as specified below. Meaning that should the percentage or number of take be exceeded from handling or from the mechanical treatment separately, then take will have been exceeded. . The following incidental take is anticipated to be no more than (annually):

- Humpback chub
    - Individuals from 31-100 mm = 5% of total number captured
    - Individuals from 101-200mm = 1% of total number captured
    - Individuals over 201 mm = no more than 5 individuals regardless of total number captured

- Razorback sucker
    - Individuals less than 20 mm = 5% of total number captured
    - Individuals 31-100 mm = 5% of total number captured
    - Individuals from 101-300 mm = 1% of total number captured
    - Individuals over 300 mm = no more than 2 individuals regardless of total number captured

Mechanical Control

Incidental take of humpback chub and razorback sucker will occur as a result of mechanical control which include fish capture and handling action taken under this action. This take will be in the form of harassment from capture and handling individuals incidentally taken while pursuing other species and in the event of injury or mortality of individuals as a result of any capture or handling event.

Based on results of past survey and monitoring efforts for humpback chub and razorback sucker by NPS, we anticipate future incidental take will be consistent with levels seen in past years, even with increased capture and handling of these fish. The anticipated level of take is dependent on size on the individuals captured, and thought to be relatively low. Incidental take during Mechanical control activities, or as a result of the physical control activity itself should not rise above the level of take of physical control and handling as specified above. Meaning that should the percentage or number of take be exceeded from handling during mechanical control separately, then take will have been exceeded. The following incidental take is anticipated to be no more than (annually):

- Humpback chub
    - Individuals from 31-100 mm = 5% of total number captured
    - Individuals from 101-200mm = 1% of total number captured
    - Individuals over 201 mm = no more than 5 individuals regardless of total number captured

- Razorback sucker
    - Individuals less than 20 mm = 5% of total number captured
    - Individuals 31-100 mm = 5% of total number captured
    - Individuals from 101-300 mm = 1% of total number captured
    - Individuals over 300 mm = no more than 2 individuals regardless of total number captured

Biological Control

We anticipate the stocking of YY-male non-native fish is reasonably certain to result in incidental take of humpback chub and razorback sucker in the Lower Colorado River Basin population. This incidental take is expected to be in the form of harm (including direct fatality) and harassment resulting from the effects of the proposed action on chub. In particular we focus on the stocking of YY-male brown trout as part of the proposed action and will later address other possible species where this technique may be applied in the future. Incidental take is anticipated to occur from the brown trout consuming eggs, larvae and sub-adult humpback chub and razorback sucker. The NPS modified a model that GCMRC developed in coordination with the service to estimate the loss of humpback chub as a result of trout stocking. Estimates of emigration and predation were based on studies of wild rainbow and brown trout in the action area and were provided by modifications of Yard et al. (2015) and Korman et al. (2012 and 2015) formulas. Modifications to this estimate also included up to date data on brown trout and humpback chub numbers provided by GCMRC and the Department. For a full description of the justification and estimation of predation please see Appendix B of this document.

Although it is possible that stocked brown trout might behave differently than the wild-born brown trout population, we anticipated that environmental conditions tied to the geographic location and density of the current fish population also plays a crucial factor in all trout behavior in the action area. As such, we accept that there is uncertainty in the possible outcome of this stocking, and will work with NPS to reevaluate models and environmental conditions prior to stocking. We estimate take in the form of harm and/or harassment by predation of larval humpback chub to range from 13, 113, and 1,915 juvenile humpback chub will be consumed by brown trout per year (see Appendix B) under low-, moderate-, and high-risk scenarios. We are currently unable to offer a similar estimate for razorback suckers in particular.

Currently, we do not have a meaningful easily monitored way to estimate take in the form of harassment of larval humpback chub and razorback sucker as a result of brown trout attempting to forage on YOY in cold water or other sub-optimal conditions. Resulting take or harassment may include energy expenditure on young humpback chub that may impact their fitness and survival. Harassment of adult humpback chub and razorback is also possible because brown trout can be aggressive and territorial while foraging. If harassment in this form happens it may result in competition and a reduction in the ability of adult humpback chub to shelter, forage, or reproduce. The Service anticipates incidental take of humpback chub and razorback sucker may be difficult to monitor over the timeframe of this action, for the following reason(s): 1) humpback chub or razorback sucker that have been consumed by brown trout cannot always be detected; 2) early detection of effects to larval humpback chub or razorback that may lead to decreased survival or fitness is not feasible; 3) detection of harassment of adults and loss of

opportunities to forage, shelter or breed are limited; 4) the status of the species is changing over time through immigration, emigration, and natural loss; and, 5) the species occur within almost 300 miles (483 km) of river including the action area in extremely remote locations, so individual humpback chub and razorback sucker are difficult to locate.

Because of the challenges of quantifying direct incidental take, the uses of surrogate measures have been adopted to determine when take has been exceeded for both humpback chub and razorback sucker. From previous work we have estimates of trout movement and presence in this area, as well as the resulting predation rate by the number of brown trout for native species in the area of the LCR confluence. For example, Yard et al. (2001) estimated that over a 3 month period, the consumption rate of humpback chub by brown trout ranged from approximately 6.8 to 25.5 humpback chub per brown trout. Since long-term monitoring of predation by brown trout is not feasible, we adopt brown trout detection estimates as a surrogate. The numbers of brown trout are a reasonable surrogate to determine the incidental take on the endangered fish given this demonstrated causal link between number of brown trout and take, through predation, of endangered species. We have estimated the level of anticipated incidental take based on a humpback chub population viability assessment used by GCMRC to evaluate the effects of LTEMP, estimates of trout movement and predation in Appendix B of this document, and the works of the GCMRC and its cooperators (Korman et al. 2012, Avery et al. 2015, Korman et al. 2015, Yard et al. 2015, Young et al. 2015, Ward 2018 in press, Yackulic, 2018). If it is estimated that YY-male brown trout stocking has contributed to the action triggers of LTEMP (Tier 1 or 2) being met then incidental take will have been exceeded. Additionally, if $\geq$ 36 individual stocked brown trout (less than 1% of annual stocking) are estimated to be in the LCR reach, measured by brown trout detected outside of the stocking reach from any stocking event, or by annual total then incidental take will have been exceeded. This number of brown trout comes from back calculating what the emigration rate of brown trout would be if the high-risk scenario of stocking were to be met, resulting in 1,915 juvenile humpback chub consumed by brown trout per year. Information gathered by the conservation measures will ensure that monitoring results are sufficient to determine when anticipated take of humpback chub and razorback sucker is exceeded.

Stocking of other non-native species, should broodstock of this technique become available, may result in similar take of humpback chub and razorback sucker. However, we are unable to provide meaningful modeling of take because we do not know; the species to be stocked, the level of piscivory of stocked species, the rate or density of stocking, location, nor the environmental conditions at stocking. As such, we offer the NPS and Service will collaborate to provide the needed models prior to stocking of any other non-native fish within the action area. Should these models indicate that take has exceed the uppermost range of humpback chub consumption set by the risk scenarios from above, 1,915 humpback chub consumed annually, then take will be exceeded. Since quantifying this form of take is difficult we offer a surrogate measure above for brown trout, which will be modified for the different non-native species to be stocked. Estimates of piscivory level, rate of emigration, level of humpback chub consumption (not to exceed 1,915 humpback chub), and back calculation to non-native fish presence or emigration rate will be used as a surrogate similar to brown trout.

Chemical Control

Chemical Control include methods such as; overwhelming ecosystem-cycling capabilities (ammonia, oxygen, carbon dioxide, pH, etc.) and application of registered piscicides for control of high and very high risk non-native species. Despite the provisions for safe capture, transport, holding, and release of humpback chub and razorback sucker from the treatment areas, there is always a risk of mortality when handling fish in these situations. Incidental take from monitoring, handling and salvage efforts is addressed above. Further, if present, it is unlikely that all humpback chub and razorback sucker will be removed by the salvage operation, and any individuals remaining in the treatment area will die due to the effects of chemical treatments. Incidental take of humpback chub and razorback sucker is reasonably certain to occur as a result of the proposed chemical treatment applications in the action area. Incidental take will result as fish die from contact with the piscicide or otherwise altered water chemistries.

The Service anticipates incidental take of humpback chub and razorback sucker from exposure to chemical treatments will be difficult to detect for the following reasons: finding a dead or impaired individual fish is unlikely as fish that are exposed to rotenone typically disappear quickly as they are carried downstream, sink to the creek bottom, or are eaten by birds and mammals. Although we cannot estimate the number of individual fish that will be incidentally taken during treatment, based on experience from past rotenone treatments, the number of humpback chub and razorback sucker killed by rotenone is likely to be low after salvage of fish. Incidental take during salvage, or as a result of the chemical treatment itself should not rise above the level of take of mechanical removal and handling as specified above. Meaning that should the percentage or number of take be exceeded from handling or from the chemical treatment separately, then take will have been exceeded.

Management of high to very high risk aquatic plants or algae that require the application of herbicides and non-toxic dyes to backwaters, off-channel areas, and low velocity tributaries to the Colorado River inside the action area are not anticipated to result in take by harm.

EFFECT OF THE TAKE

In this BO, the Service determines that this level of anticipated take is not likely to result in jeopardy to these species or destruction or adverse modification of critical habitats. We reach this conclusion because the anticipated take of individual humpback chub and razorback sucker is low relative to the size of the overall population. The purpose of the all activities in this proposed action, including the stocking of YY-male fish, is to manage and decrease non-native populations that adversely impact humpback chub and razorback suckers. Although some activities may result in incidental take and impacts to these species in the short-term, we anticipate there will be an overall positive effect at the population level long-term because of the reduction in non-native species populations and the corresponding reduced predation and competition effects to the native species. Additionally, although by definition one of the PCEs are impacted by definition in that it adds non-native fish to critical habitat; we anticipate that so few stocked YY-male fish will be added that it will have limited impact to critical habitat and not to the level that all PCEs will be impacted. In other words it will not decrease the conditions of critical habitat to such an extent that it no longer has a conservation benefit to the species.

REASONABLE AND PRUDENT MEASURES AND TERMS AND CONDITIONS

We determine that the proposed action incorporates sufficient conservation measures to monitor and minimize the effects of incidental take of humpback chub and razorback sucker. Take is estimated to be relatively low when compared to population estimates of adult humpback chub and razorback sucker and each action will cease prior to the need of severe intervention to protect humpback chub or razorback sucker population level impacts. Long-term positive impacts to native species, including humpback chub and razorback suckers, are anticipated by incorporating these activities to combat non-native species known for their detrimental impacts in the action area. The NPS is taking a pro-active approach to managing deleterious non-native species, and seek to move toward their fulfillment of their 7(a)(1) responsibilities for humpback chub and razorback sucker under this proposed action. All reasonable measures to minimize take have been incorporated into the project description. Thus, no additional reasonable and prudent measures are included in this incidental take statement. Annual monitoring reports will be submitted to this office.

Disposition of Dead or Injured Listed Species

Upon locating a dead, injured, or sick listed species initial notification must be made to the Service's Law Enforcement Office, 2450 W. Broadway Rd, Suite 113, Mesa, Arizona, 85202, telephone: 480/967-7900) within three working days of its finding. Written notification must be made within five calendar days and include the date, time, and location of the animal, a photograph if possible, and any other pertinent information. The notification shall be sent to the Law Enforcement Office with a copy to this office (AESO). Care must be taken in handling sick or injured animals to ensure effective treatment and care and in handling dead specimens to preserve the biological material in the best possible state.

CONSERVATION RECOMMENDATIONS

Section 7(a) (1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The following recommendations are;

1) Continued collaboration and work with researchers to create more robust non-native fish population estimates.
2) Should resources be available, collaborate with management partners to examine the relationship of non-native fish coming through Glen Canyon Dam and resulting survival and establishment of these species.
3) Further explore, and track, non-native species in relationship to changing temperatures of water releases from Glen Canyon Dam and Lake Mead.

REINITIATION NOTICE

This concludes formal consultation on the action outlined in the Project Description of this Opinion. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, actions will cease pending reinitiation.

In keeping with our trust responsibilities to American Indian Tribes, we encourage you to continue to coordinate with the Bureau of Indian Affairs in the implementation of this consultation and, by copy of this biological opinion, are notifying the Hopi Tribe, Hualapai Tribe, Kaibab Band of Paiute Indians, Navajo Nation, Shivwits Band of Paiute Indians, Southern Paiute Consortium, Pueblo of Zuni, and Bureau of Indian Affairs of its completion. We also encourage you to coordinate this project with the Arizona Game and Fish Department.

We appreciate NPS' addressing our collective responsibilities under 7(a)(1) and this plan that identifies and minimizes effects to listed species from this project. Please refer to the consultation number 02EAAZ00-2019-F-0214 in future correspondence concerning this project. If you have questions or need information regarding this Opinion, please call Jessica Gwinn or myself at (602) 242-0210 or email jessica_gwinn@fws.gov.

cc (electronic):
Regional Supervisor, Arizona Game and Fish Department, Flagstaff, AZ
Assistant Field Supervisor, Fish and Wildlife Service, Flagstaff, AZ (Attn: Shaula Headwall, Brian Wooldridge)
Office of Assistant Secretary for Water and Science (Attn: Sarah Rinkevich)
Project Leader, Arizona Fish and Wildlife Conservation Office, Flagstaff AZ
Director, Cultural Resource Center, Chemehuevi Tribe, Havasu Lake, CA
Cultural Compliance Technician, Museum, Colorado River Indian Tribes, Parker, AZ
Tribal Secretary, Havasupai Tribe, Supai, AZ
Director, Hopi Cultural Preservation Office, Kykotsmovi, AZ
Director, Cultural Resources, Kaibab Band of Paiute Indians, Fredonia, AZ
Director, Zuni Heritage and Historic Preservation Office, Zuni, NM
Environmental Protection Officer, Environmental Quality Services, Western Regional Office, Bureau of Indian Affairs, Phoenix, AZ
Chief, Habitat Branch, Arizona Game and Fish Department, Phoenix, AZ

Literature Cited

Ackerman, M.W. 2008. Native fish monitoring activities in the Colorado River, Grand Canyon: Flagstaff, Arizona. SWCA Environmental Consultants, report to Grand Canyon Monitoring and Research Center, Cooperative Agreement 04WRAG0011. 77 pp.

Albrecht, B.A., P.B. Holden, R.B. Kegerries, and M.E. Golden. 2010. Razorback sucker recruitment in Lake Mead, Nevada-Arizona, Why here? Lake and Reservoir Management 26:4.

Albrecht, B., R. Kegerries, J.M. Barkstedt, W.H. Brandenburg, A.L. Barkalow, S.P. Platania, M. McKinstry, B. Healy, J. Stolberg, and Z. Shattuck. 2014. Razorback sucker *Xyrauchen texanus* research and monitoring in the Colorado River inflow area of Lake Mead and the Lower Grand Canyon, Arizona and Nevada. Final report prepared by BIO-WEST, Inc., for U.S. Bureau of Reclamation, Upper Colorado Region, Salt Lake City, Utah.

Alpine, A. E. (editor). 2010. Hydrological, geological, and biological site characterization of breccia pipe uranium deposits in northern Arizona. U.S. Geological Survey, Scientific Investigations Report 2010-5025.

Andersen, M.E. 2009. Status and trends of the Grand Canyon population of humpback chub. U.S. Geological Survey Fact Sheet 2009-3035, April.

Andersen, M.E., M.W. Ackerman, K.D. Hilwig, A.E. Fuller, and P.D. Alley. 2010. Evidence of young humpback chub overwintering in the mainstem Colorado River, Marble Canyon, Arizona, USA. The Open Fish Science Journal 2010 (3): 42–50.

Angradi, T.R. and D.M. Kubly. 1994. Concentration and transport of particulate organic matter below Glen Canyon Dam on the Colorado River, Arizona. Journal of the Arizona-Nevada Academy of Science 28(1/2): 12–22.

Arizona Game and Fish Department (AGFD). 1996. The ecology of Grand Canyon backwaters. Cooperative Agreement Report (9 FC-40-07940) to Glen Canyon Environmental Studies, Flagstaff, Ariz.

Arizona Game and Fish Department (AGFD). 2001. *Gila cypha,* humpback chub. Heritage Data Management System, Phoenix, Arizona.

Avery, L.A., J. Korman, and W.R. Persons. 2015. Effects of increased discharge on spawning and age-0 recruitment of rainbow trout in the Colorado River at Lees Ferry, Arizona. North American Journal of Fisheries Management 35: 671–680.

Bachman, R.A. 1984. Foraging behavior of free-ranging wild and hatchery brown trout in a stream. Transactions of the American Fisheries Society 113: 1-32.

Bartholomew, A. and J.A. Bohnsack. 2005. A review of catch-and-release angling mortality with implications for no-take reserves. Reviews in Fish Biology and Fisheries 15: 129-154.

Behn, K.E., T.A. Kennedy, and R.O. Hall, Jr. 2010. Basal resources in backwaters of the Colorado River below Glen Canyon Dam - Effects of discharge regimes and comparison with mainstem depositional environments. U.S. Geological Survey Open-File Report 2010-1075. Available at http://pubs.usgs.gov/of/2010/1075/.

Bestgen, K.R. 1990. Status review of the razorback sucker, *Xyrauchen texanus*. Report to U.S. Fish and Wildlife Service, Salt Lake City, Utah. Contribution 44, Larval Fish Laboratory, Colorado State University, Fort Collins, Colorado.

Bettinger, J.M., and P.W. Bettoli. 2002. Fate, dispersal, and persistence of recently stocked and resident rainbow trout in a Tennessee tailwater. North American Journal of Fisheries Management 22: 425-432.

Bjornn, T.C., and J. Mallet. 1964. Movements of planted and wild trout in an Idaho river system. Transactions of the American Fisheries Society 93: 70-76.

Blakely, T.J., W.L. Chadderton, and J.S. Harding. 2005. The effects of rotenone on orchard-pond invertebrate communities in the Motueka area, South Island, New Zealand. Research and Development Series 220. Department of Conservation, Wellington, New Zealand.

Blinn, D.W., C. Runck, D.A. Clark, and J.N. Rinne. 1993. Effects of rainbow trout predation on Little Colorado spinedace. Transactions of the American Fisheries Society 122: 139-143.

Bonar, S.A., W.A. Hubert, and D.W. Willis (eds). 2015. Standard methods for sampling North American freshwater fishes. American Fisheries Society. Bethesda, Maryland.

Bryan, S.D., A.T. Robinson, and M.J. Fry. 2000. Native-nonnative fish interactions in the lower Salt and Verde rivers. Final Report submitted to the Bureau of Reclamation. Cooperative Agreement No. 98-FG-32-0240. Department, Phoenix, Arizona.

Carothers, S.W. and B.T. Brown. 1991. The Colorado River through Grand Canyon: Natural history and human change. University of Arizona Press, Tucson, Arizona.

Cho, S.J., C.A. Caldwell, and W.R. Gould. 2011. Physiological stress responses of Rio Grande silvery minnow: effects of individual and multiple physical stressors of handling, confinement, and transportation. North American Journal of Fisheries Management 29: 1698-1706.

Christensen, N.S., A.W. Wood, N. Voisin, D.P. Lettenmaier, and R.N. Palmer, 2004. The effects of climate change on the hydrology and water resources of the Colorado River Basin" *Climate Change* 62: 337–363.

Clarkson, R.W. and M.R. Childs. 2000. Temperature effects of hypolimnial-release dams on early life stages of Colorado River Basin Big-River Fishes. Copeia 2002: 402–412.

Clarkson, R.W., A.T. Robinson, and T.L. Hoffnagle. 1997. Asian tapeworm (*Bothriocephalus acheilognathi*) in native fishes from the Little Colorado River, Grand Canyon, Arizona. Great Basin Naturalist 57: 66–69.

Coggins, L.G. Jr. 2008. Abundance trends and status of the Little Colorado River population of humpback chub; an update considering 1989-2006 data. U.S. Geological Survey Open-File Report 2007-1402.

Coggins, L.G. Jr. and C.J. Walters. 2009. Abundance trends and status of the Little Colorado River population of humpback chub: An update considering data from 1989–2008. Open-File Report 2009-1075, U.S. Geological Survey.

Cone, R.S. and C.C. Krueger. 1988. Comparison of survival, emigration, habitat use, marking mortality, and growth between two strains of brook trout in Adirondack ponds. North American Journal of Fisheries management 8: 497-504.

Converse, Y.K., C.P. Hawkins, and R.A. Valdez. 1998. Habitat relationships of sub adult humpback chub in the Colorado River through Grand Canyon: Spatial variability and implications of flow regulation. Regulated Rivers: Research and Management 14: 267–284.

Dodrill, M.J., C.B. Yackulic, B. Gerig, W.E. Pine, J. Korman, and C. Finch. 2015. Do management actions to restore rare habitat benefit native fish conservation? Distribution of juvenile native fish among shoreline habitats of the Colorado River. River Research and Applications. doi:10.1002/rra.2842.

Dodrill, M. 2018. Colorado River 30 Mile humpback chub detections. Personal Communication.

Donner, K.S. 2011. Secondary production rates, consumption rates, and trophic basis of production of fishes in the Colorado River, Grand Canyon, AZ: An assessment of potential competition for food. M.S. thesis, Idaho State University, Pocatello, Idaho, April.

Douglas, M.E. and P.C. Marsh. 1996. Population estimates/population movements of *Gila cypha*, an endangered cyprinid fish in the Grand Canyon region of Arizona. Copeia 1: 15–28. Available at http://www.jstor.org/stable/pdfplus/1446938.pdf.

Evens, J.M. 2008. Ecosystem implications of invasive aquatic plans and aquatic plant control in Florida springs. In: Summary and synthesis of available literature on the effects of nutrients on spring organisms and systems (ed. M.T. Brown). Pp. 249-270. Tallahassee: Florida Department of Environmental Protection.

Finlayson, B., R. Schnick, D. Skaar, J. Anderson, L. Demong, D. Duffield, W. Horton, and J. Steinkjer. 2010. Planning and standard operating procedures for the use of rotenone in fish management – rotenone SOP manual. American Fisheries Society, Bethesda, Maryland.

Finney, S. 2006. Adult and juvenile humpback chub monitoring for the Yampa River population,

2003-2004. Final Report of U.S. Fish and Wildlife Service to Upper Colorado River Endangered Fish Recovery Program, Denver, Colorado.

Folmar L.C., J.Q. Sanders, and A.M. Julin. 1979. Toxicity of the herbicide glyphosate and several of its formulations to fish and aquatic invertebrates. Archive of Environmental Contaminant Toxicology 8: 269-278.

Francis, T., D.S. Elverud, B.J. Schleicher, D.W. Ryden, and B. Gerig. 2015. San Juan River Arm of Lake Powell razorback sucker (*Xyrauchen texanus*) Survey: 2012, draft interim progress report to the San Juan River Endangered Fish Recovery Program.

Francis-Floyd, R. 2009. Stress: its role in fish disease. Circular CIR919. Institute of Food and Agricultural Sciences. Florida Cooperative Extension Service, University of Florida. Gainesville. 4pp.

Fuller, M.J. 2009. Lower Yampa River channel catfish and smallmouth bass control program, Colorado, 2001-2006. U.S. Fish and Wildlife Service, Vernal, Utah. 32pp.

Garfin, G., G. Franco, H. Blanco, A. Comrie, P. Gonzalex, T. Piechota, R. Smyth, and R. Waskom, 2014, "Chapter 20: Southwest," pp. 462–486 in Climate change impacts in the United States: The third national climate assessment, J.M. Melillo, T.C. Richmond, and G.W. Yohe (eds.), U.S. Global Change Research Program. DOI:10.7930/JO8G8HMN.

Gilbert, C.H. and N.B. Scofield. 1898. Notes on a collection of fishes from the Colorado basin in Arizona. Proceedings of the U.S. National Museum 20: 1131.

Gloss, S.P. and L.C. Coggins, Jr. 2005. Fishes of the Grand Canyon, in S.P. Gloss, J.E. Lovich, and T.S. Melis eds. The state of the Colorado River ecosystem in Grand Canyon. U.S. Geological Survey Circular 1282, pp33-56. U.S. Geological Survey Open-File Report 2010-1032. 73 pp.

Gorman, O.T. 1994. Habitat use by humpback chub, *Gila cypha*, in the Little Colorado River and other tributaries of the Colorado River. Prepared by U.S. Fish and Wildlife Service, Arizona Fisheries Resources Office, Flagstaff, Arizona, for U.S. Bureau of Reclamation, Glen Canyon Environmental Studies.

Gorman, O. and D.M. Stone. 1999. Ecology of spawning humpback chub, *Gila cypha*, in the Little Colorado River near Grand Canyon, Arizona. Environmental Biology of Fishes 55(1): 115-133.

Grand Canyon Monitoring and Research Center (GCMRC). 2014. Grand Canyon Monitoring and Research Center fiscal year 2014 annual project report for the Glen Canyon Dam Adaptive Management Program, annual report prepared for Upper Colorado Region, Bureau of Reclamation.

Hamilton, B.T., S.E. Moore, T.B. Williams, N. Darby and M.R. Vinson. 2009. Comparative effects of rotenone and antimycin on macroinvertebrate diversity in two streams in Great Basin National Park, Nevada. North American Journal of Fisheries Management 29: 1620-1635.

Haven, A. C. 1980. Population studies of game fish and evaluation of managed lakes in the upper Crook Inlet drainage. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1979-1980, Project F-9-12, 21 (G-111-D), Juneau.

Harper, C. and J.C. Wolf. 2009. Morphological effects of stress response in fish. ILAR Journal 50(44): 387.

Healy, B. 2018. Brown trout abundance. Personal communication email to Melissa Trammell sent October 17, 2018.

Healey, B.D., R. Schelly, C. Nelson, E. Omana-Smith, M. Trammell, and R. Koller. 2018. Review of effective suppression of nonnative fishes in Bright Angel Creek, 2012-2017, with recommendations for humpback chub translocations. Report prepared for the Upper Colorado Region, Bureau of Reclamation, Interagency agreement number: R12PG40034. April 2018, DOI: 10.13140/RG.2.2.18961.53607

Heimer, J.T., W.M. Frazier, and J.S. Griffith. 1985. Post-stocking performance of catchable-size hatchery rainbow trout with and without pectoral fins. North American Journal of Fisheries Management 5: 21-25.

Helfrich, L. A. and W.T. Kendall. 1982. Movements of hatchery-reared rainbow, brook, and brown trout stocked in a Virginia mountain stream. Progressive Fish-Culturist 44: 3–7.

High, B., and K.A. Meyer. 2009. Survival and dispersal of hatchery triploid rainbow trout in an Idaho river. North American Journal of Fisheries Management 29: 1797-1805.

Hoffnagle, T.L., A. Choudhury, and R.A. Cole. 2006. Parasitism and body condition in humpback chub from the Colorado and Little Colorado Rivers, Grand Canyon, Arizona. Journal of Aquatic Animal Health 18(3): 184-193.

Hunt, T. A. 2008. The effects of capture by trammel nets on native Arizona fishes. Masters Thesis. Northern Arizona University, Flagstaff. 57 pp.

Hunt, T.A., D.L. Ward, C.R. Propper and A.C. Gibb. 2012. Effects of capture by trammel net on Colorado River native fishes. Journal of Fish and Wildlife Management 3(11): 133-141.

Jacobs, J. 2011. The sustainability of water resources in the Colorado River Basin, in The Bridge: Linking Engineering and Society, National Academy of Engineering, Winter:6–12.

Jordan, D.S. 1891. Report of explorations in Colorado and Utah during the summer of 1889 with an account of the fishes found in each of the river basins examined. Bulletin of the United States Fish Commission 9: 24.

Kaeding, L.R. and M.A. Zimmerman. 1983. Life history and ecology of the humpback chub in the Little Colorado and Colorado Rivers in Grand Canyon. Transactions of the American Fisheries Society 112: 577–594.

Kegerries, R., B. Albrecht, R. Rogers, E. Gilbert, W.H. Brandenburg, A.L. Barkalow, S.P. Platania, M. McKinstry, B. Healy, J. Stolberg, E. Omana Smith, C. Nelson, and H. Mohn. 2015. Razorback sucker (*Xyrauchen texanus*) research and monitoring in the Colorado River inflow area of Lake Mead and the Lower Grand Canyon, Arizona and Nevada. Final Report, prepared by BIO-WEST, Inc., for the U.S. Bureau of Reclamation, Upper Colorado Region, Salt Lake City, Utah.

Kennedy, T.A., W.F. Cross, R.O. Hall, Jr., C.V. Baxter, and E.J. Rosi-Marshall. 2013. Native and nonnative fish populations of the Colorado River are food limited - Evidence from new food web analyses. U.S. Geological Survey Fact Sheet 2013–3039. Available at http://pubs.usgs.gov/fs/2013/3039/.

Kennedy, T.A. and S.P. Gloss. 2005. Aquatic Ecology: The role of organic matter and invertebrates, Chapter 5 in The state of the Colorado River ecosystem in Grand Canyon, U.S. Geological Survey Circular 1282, S.P. Gloss et al. (eds.), U.S. Geological Survey, Reston, Virginia.

Kennedy, T.A., J.D. Muehlbauer, C.B. Yackulic, D.A. Lytle, S.W. Miller, K.L. Dibble, E.W. Kortenhoeven, A.N. Metcalfe, and C.V. Baxter. 2016. Flow management for hydropower extirpates aquatic insects, undermining river food webs. BioScience.

Kennedy, T.A. and B.E. Ralston. 2011. Biological responses to high-flow experiments at Glen Canyon Dam, pp. 93–125 *In* Effects of three high flow experiments on the Colorado River ecosystem downstream from Glen Canyon Dam, Arizona, T.S. Melis (ed.), Circular 1366, U.S. Geological Survey, Reston, Virginia.

Kirsch, P.H. 1889. Notes on a collection of fishes obtained in the Gila River at Fort Thomas, Arizona. Proceedings of the U.S. National Museum 11: 555-558.

Korman, J., S.J.D. Martell, C.J. Walters, A.S. Makinster, L.G. Coggins, M.D. Yard, W.R. Persons, and T. Quinn. 2012. Estimating recruitment dynamics and movement of rainbow trout (*Oncorhynchus mykiss*) in the Colorado River in Grand Canyon using an integrated assessment model. Canadian Journal of Fisheries and Aquatic Sciences 69(11): 1827-1849.

Korman, J., M.D. Yard, and C.B. Yackulic. 2015. Factors controlling the abundance of rainbow trout in the Colorado River in Grand Canyon in a reach utilized by endangered humpback chub. Canadian Journal of Fisheries and Aquatic Science 73: 105–124.

Korman, J. and M.D. Yard. 2017. Trends in rainbow trout recruitment, abundance, survival, and growth during a boom-and-bust cycle in a tailwater fishery. Transactions of the American Fisheries Society, available online at http://dx.doi.org/10.1080/00028487.2017.1317663.

Maddux, H.R, W.R. Noonan, and L.A. Fitzpatrick. 1993. Draft Colorado River endangered fishes critical habitat, biological support document. U.S. Fish and Wildlife Service, Salt Lake City, Utah. 225pp.

Marcogliese, D.J. and G.W. Esch. 1989. Experimental and natural infection of planktonic and benthic copepods by the Asian tapeworm, *Bothriocephalus acheilognathi*. Proceedings of the Helminthological Society of Washington 56(2): 151–155.

Marsh, P.C. and M.E. Douglas. 1997. Predation by introduced fishes on endangered humpback chub and other native species in the Little Colorado River, Arizona. Transaction of the American Fisheries Society 126: 343.

Marsh, P.C., T.E. Dowling, B.R. Kesner, T.F. Turner, and W.L. Minckley. 2015. Conservation to stem imminent extinction: The fight to save razorback sucker *Xyrauchen texanus* in Lake Mohave and its implications for species recovery. Copeia 103(1): 141–156.

Marsh, P.C. and D.R. Langhorst. 1998. Feeding and fate of wild larval razorback sucker. Environmental Biology of Fisheries 21(1): 59-67.

Marsh, P.C., T.E. Dowling, B.R. Kesner, T.F. Turner, and W.L. Minckley. 2015. Conservation to stem imminent extinction: The fight to save razorback sucker *Xyrauchen texanus* in Lake Mohave and its implications for species recovery. Copeia 103(1):141–156.

McAda, C.W. and R.S. Wydoski. 1980. The razorback sucker, *Xyrauxchen texanus*, in the upper Colorado River basin, 1974-76. U.S. Fish and Wildlife Service Technical Paper 99. 50pp.

McCarthy, C.W. and W.L. Minckley. 1987. Age estimation for razorback sucker (Pisces: Catostomidae) from Lake Mohave, Arizona and Nevada. Journal of the Arizona-Nevada Academy of Science 21: 87-97.

Melaas, C.L., K.D. Zimer, M.G. Butler and M.A. Hanson. 2001. Effects of rotenone on aquatic invertebrate communities in prairie wetlands. Hydrobiologia 459: 177-186.

Minckley, W.L. 1973. The Fishes of Arizona. Arizona Game and Fish Department, Phoenix, Arizona.

Minckley, W.L. 1983. Status of the razorback sucker, *Xyrauchen texanus* (Abbott), in the lower Colorado River Basin. The Southwestern Naturalist 28: 165-187.

Minckley, W.L. 1991. Native fishes of the Grand Canyon region: An obituary? Pages 124-177 in Committee to review the Glen Canyon environmental studies, water science and technology board, National Research Council, eds., Colorado River Ecology and Dam Management. National Academy Press, Washington DC. 276 pp.

Mohn, H., B. Albrecht, R.J. Rogers, and R. Kegerries. 2015. Razorback sucker studies on Lake

Mead, Nevada and Arizona: 2014–2015 Final Annual Report, prepared for U.S. Bureau of Reclamation, Lower Colorado River Multi-Species Conservation Program, Boulder City, Nevada.

Moore, S.E., MA. Kulp, B. Rosenlund, J. Brooks and D. Propst. 2008. A field manual for the use of antimycin A for restoration of native fish populations. Natural resource report NPS/NRPC/NRR-2008/001. National Park Service, Fort Collins, Colorado.

Moring, J. R. 1993. Effect of angling effort on catch rate of wild salmonids in streams stocked with catchable-size trout. North American Journal of Fisheries Management 13: 234-237.

Murphey, B.R. and D.W. Willis eds. 1996. Fisheries techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.

National Park Service (NPS). 2005. Final Environmental Impact Statement Colorado River Management Plan. Grand Canyon National Park. Accessed March 2018.

National Park Service. 2013. Comprehensive fisheries management plan, environmental assessment, Grand Canyon National Park and Glen Canyon National Recreation Area, Coconino County, Arizona. U.S. Department of the Interior.

National Park Service (NPS). 2013b. Shinumo Creek humpback chub monitoring and translocation June 12-13, 2013. Report prepared for the Upper Colorado Region, Bureau of Reclamation, Interagency Agreement Number: 09-AA-40-2890.

National Academies of Science (NAS). 2007. Colorado River Basin water management: Evaluating and adjusting to hydro climatic variability, Feb.

Nickum, J.G. 1988. Guidelines for use of fishes in field research. Fisheries 13(22): 16-23.

Osmundson, D.B. and L.R. Kaeding. 1989. Studies of Colorado squawfish and razorback sucker use of the “15-mile reach” of the Upper Colorado River as part of conservation measures for the Green Mountain and Ruedi Reservoir water sales. Final Report, U.S. Fish and Wildlife Service, Region 6, Grand Junction, Colorado. 81pp.

Paukert, C.P., D.L. Ward, P.J. Sponholtz and K.D. Hilwig. 2005. Effects of repeated hoopnetting and handling on bonytail chub. Journal of Freshwater Ecology 20(44): 649-653.

Paukert, C.P., L.G. Coggins, and C.E. Flaccus. 2006. Distribution and movement of humpback chub in the Colorado River, Grand Canyon, based on recaptures. Transactions of the American Fisheries Society 135: 539-544.

Perna, C. and D. Burrows. 2005. Improved dissolved oxygen status following removal of exotic weed mats in important habitat lagoons of the tropical Burdekin River floodplain, Australia. Marine Pollution Bulletin 51: 138-148.

Persons, W.R., D.L. Ward and L.A. Avery. 2013. Standardized methods for Grand Canyon fisheries research 2015 (ver 1.1, January 2015), U.S. Geological Survey, Techniques and Methods, book 2, chapter A12, 19pp.

Persons, W.R., D.R. Van Haverbeke, and M.J. Dodrill. 2017. Colorado River fish monitoring in Grand Canyon, Arizona: 2002-14 humpback chub aggregations. U.S. Geological Survey Open-File Report 2016-1177, 43 pp.

Pine W.E. III,, B. Healy, E. Omana Smith, M. Trammell, D. Speas, R. Valdez, M. Yard, C. Walters, R. Ahrens, R. Van Haverbeke, D. Stone, and W. Wilson. 2013. An individual based model for population viability analysis of humpback chub in Grand Canyon, North American Journal of Fisheries Management 33(3): 626-641.

Portz, D. E. 2009. Stress induced factors of bonytail hatchery and stocking practices. Report to the Lower Colorado River Multi-Species Conservation Program from Bureau of Reclamation. Denver Technical Service Center, Denver, Colorado, 50 pp.

Robinson, A.T. and M.R. Childs. 2001. Juvenile growth of native fishes in the Little Colorado River and in a thermally modified portion of the Colorado River. North American Journal of Fisheries Management 21: 809–815.

Rogowski, D.L., Osterhoudt, R.J., and Boyer, J.K., 2017. Colorado River fish monitoring in the Grand Canyon, Arizona--2016 annual report. Phoenix, Arizona Game and Fish Department, submitted to U.S. Geological Survey, Grand Canyon Monitoring and Research Center, Flagstaff, Ariz., 55 p.

Rogowski, D.L., R. Osterhoundt, and H.E. Mohn. 2018. Humpback chub range expansion western Grand Canyon. Western North American Naturalis 78(1).

Rosi-Marshall, E.J., T.A. Kennedy, D.W. Kincaid, W.F. Cross, H.A.W. Kelly, K.A. Behn, T. White, R.O. Hall, Jr., and C.V. Baxter. 2010. Short-term effects of the 2008 high-flow experiment on macroinvertebrates in the Colorado River below Glen Canyon Dam, Arizona. U.S. Geological Survey Open-File Report 2010–1031, U.S. Geological Survey, Reston, Virginia.

Runge, M.C., C.B. Yackulic, L.S. Bair, T.A. Kennedy, R.A. Valdez, C. Ellsworth, J.L. Kershner, R.S. Rodgers, M.A. Trammell and K.L. Young. 2018. Brown trout in the Lees Ferry reach of the Colorado River-Evaluation of causal hypotheses and potential interventions, U.S. Geological Survey Open-File Report 2018-1069, 83 pp.

Ruppert, J.B. and R.T. Muth. 2011. Effects of electrofishing fields on captive embryos and larvae of razorback sucker. North American Journal of Fisheries Management 17(1) 160-166 pp.
Schindler, D.W., 2001. The cumulative effects of climate warming and other human stresses on Canadian freshwaters in the new millennium. Canadian Journal of Fisheries and Aquatic Sciences 58: 18–29.

Schreck, C. B. and P.B Moyle, (eds). 1990. Methods for fish biology. American Fisheries Society. Bethesda, Maryland.

Shannon, J.P., D.W. Blinn, and L.E. Stevens. 1994. Trophic interactions and benthic animal community structure in the Colorado River, Arizona, U.S.A. Freshwater Biology 31: 213-220.

Sharpe, C.S., D.A. Thompson, H.L. Blankenship, and C.B. Schreck. 1998. Effects of routine handling and tagging procedures on physiological stress responses in juvenile Chinook salmon. The Progressive Fish Culturist 60(22): 81.

Skurdal, J., O. Hegge, and T. Hesthagen. 1989. Exploitation rate, survival and movements of brown trout (*Salmo trutta L.*) stocked at takeable size in the regulated rivers Lagen and Otta, southern Norway. Regulated Rivers: Research and Management 3: 247-253.

Spurgeon, J.J., C.P. Paukert, B.D. Healy, M.T. Trammell, D.W. Speas, and E. Omana-Smith. 2015. Translocation of humpback chub into tributary streams of the Colorado River: Implications for conservation of large-river fishes. Transactions of the American Fisheries Society 144(3): 502–514.

Stevens, L.E., F.R. Protiva, D.M. Kubly, V.J. Meretsky, and J. Petterson. 1997. The ecology of Kanab ambersnail (Succineidae: *Oxyloma haydeni kanabensis* Pilsbry, 1948) at Vasey's Paradise, Grand Canyon, Arizona. 1995 Final Report. Edited by Glen Canyon Environmental Studies Program. Flagstaff, AZ: U.S. Department of the Interior, Bureau of Reclamation, Glen Canyon Environmental Studies Program Report.

Sublette, J.E., M.D. Hatch, and M. Sublette. 1990. The fishes of New Mexico. University of New Mexico Press, Albuquerque, New Mexico. 393 pp.

Sweetser, M.G., S.D. Bryan, and A.T. Robinson. 2002. Movement, distribution, and predation: *Lepidomeda vittata* and nonnative salmonids in eastern Arizona. Western North American Naturalist 62(2): 197-205.

Sweka, J. A. and K. J. Hartman. 2001. Fall and winter brook trout prey selection and daily ration. Proceedings of the Southeastern Association of Fish and Wildlife Agencies 55: 8-22.

Treanor, H.B., A.M. Ray, M. Layhee, B.J. Watten, J.A. Gross, R.E. Gresswell and M.AH. Webb. 2017. Using carbon dioxide in fisheries and aquatic invasive species management. Fisheries 42(12): 621-628.

Tyus, H.M. and C.A. Karp. 1989. Habitat use and streamflow needs of rare and endangered fishes, Yampa River, Colorado. US Fish and Wildlife Service, Biological Reports 89(14): 1-27.

U.S. Army Corps of Engineers (USACE). 2013. Acoustic fish deterrents, Available at http://glmris.anl.gov/documents/docs/anscontrol/AcousticFishDeterrents.pdf. Accessed

November 14, 2018.(USBR), Bureau of Reclamation. 1995. Operation of Glen Canyon Dam Final Environmental Impact Statement. Department of Interior, Bureau of Reclamation.

U.S. Bureau of Reclamation (Reclamation). 2007. Record of Decision, Colorado River interime guildlines for the Lower Basin shortages and the coordinate operation for Lake Powell and Lake Mead. DOI, Bureau of Reclamation.

U.S. Bureau of Reclamation (Reclamation). 2011. Environmental assessment - Non-native fish control downstream from Glen Canyon Dam. U.S. Department of the Interior, Bureau of Reclamation, Upper Colorado River Region, Salt Lake City, Utah.

U.S. Bureau of Reclamation (Reclamation). 2012. Colorado River Basin water supply and demand study. DOI, Bureau of Reclamation.

U.S. Bureau of Reclamation. 2016. Environmental assessment – Long-term experimental management program for Glen Canyon Dam. U.S. Department of the Interior, Bureau of Reclamation, Upper Colorado River Region, Salt Lake City, Utah.

U.S. Environmental Protection Agency (USEPA). 2004. National water quality inventory: Report to Congress, 2004 Reporting Cycle, Office of Water, Washington, D.C. Available at http://water.epa.gov/lawsregs/guidance/cwa/305b/2004report_index.cfm.

U.S. Fish and Wildlife Service (Service). 1990. Humpback chub recovery plan. U.S. Fish and Wildlife Service, Denver, Colorado. 43pp.

U.S. Fish and Wildlife Service (Service). 1991. Razorback sucker, *Xyrauchen texanus*, determined to be an endangered species: Final Rule. Federal Register 58: 54957-54967

U.S. Fish and Wildlife Service (Service). 1994. Biological Opinion for stocking sportfish species into the Lower Colorado River; rainbow trout and channel catfish (22410-1994-F-0244).

U.S. Fish and Wildlife Service (Service). 1994. Final rule, determination of critical habitat for the Colorado River endangered fishes: razorback sucker, Colorado squawfish, humpback chub, and bonytail chub. Federal Register 59: 13374-13400.

U.S. Fish and Wildlife Service (Service). 1998. Razorback sucker (*Xyrauchen texanus*) recovery plan. Mountain-Prairie Region (6). Denver, Colorado. 81 pp.

U.S. Fish and Wildlife Service (Service). 2002. Razorback sucker (*Xyrauchen texanus*) recovery goals: Amendment and supplement to the razorback sucker recovery plan. Mountain-Prairie Region (6), Denver, Colorado.

U.S. Fish and Wildlife Service (Service). 2011. Biological and conference opinion on the wildlife and sport fish restoration funding of Arizona Game and Fish Department's statewide urban fisheries stocking program for 2011-2021. Consultation 22410-2008-F- 4486. Arizona Ecological Services Office, Phoenix, Arizona.

U.S. Fish and Wildlife Service (Service). 2013. Final Biological Opinion for the comprehensive fish management plan, Coconino County, Arizona. U.S. Fish and Wildlife Service, Arizona Ecological Services Field Office.

U.S. Fish and Wildlife Service (Service). 2016. Biological Opinion for the Glen Canyon Dam Long-Term Experimental and Management Plan, Coconino County, Arizona. U.S. Fish and Wildlife Service, Arizona Ecological Services Field Office.

U.S. Fish and Wildlife Service. 2017. Species status assessment for the humpback chub (*Gila cypha*). U.S. Fish and Wildlife Service, Mountain-Prairie Region (6), Denver, CO. 236 pages.

U.S. Fish and Wildlife Service. 2018. Humpback chub (*Gila cypha*) 5-year review: Summary and evaluation. U.S. Fish and Wildlife Service, Mountain-Prairie Region (6), Denver, CO. 15 pages.

U.S. Fish and Wildlife Service. 2018b. Species status assessment for the razorback sucker (*Xyrauchen texanus*). U.S. Fish and Wildlife Service, Mountain-Prairie Region (6), Denver, CO.

U.S. Fish and Wildlife Service (Service). 2018c. Biological Opinion for the Arizona Game and Fish Department Lees Ferry rainbow trout stocking, Coconino County, Arizona. U.S. Fish and Wildlife Service, Arizona Ecological Services Field Office.

Valdez, R.A. and G.H. Clemmer. 1982. Life history and prospects for recovery of the humpback chub and bonytail chub, pp. 109–119 *In* Fishes of the Upper Colorado River System: Present and Future, W.H. Miller et al. (eds.), American Fisheries Society, Western Division, Bethesda, Maryland.

Valdez, R.A., D.A. House, M.A. McLeod, and S.W. Carothers. 2012. Review and summary of razorback sucker habitat in the Colorado River system, Report number1. Agency review draft prepared by SWCA, Environmental Consultants for the U.S. Bureau of Reclamation.

Valdez, R.A. and W.J. Masslich. 1999. Evidence of reproduction of humpback chub in a warm spring of the Colorado River in Grand Canyon, Arizona. The Southwestern Naturalist 44(3): 384–387.

Valdez, R.A. and R.J. Ryel. 1995. Life history and ecology of the humpback chub (*Gila cypha*), in the Colorado River, Grand Canyon, Arizona: Final Report. Available at http://www.gcmrc.gov/library/reports/biological/Fish_studies/gces/valdez1995f.pdf

Valdez and Ryel 1997. Life history and ecology of the humpback chub in the Colorado River in Grand Canyon, Arizona, pp. 3–31 *In* Proceedings of the Third Biennial Conference of Research on the Colorado Plateau, C. Van Riper III and E. T. Deshler (eds.).

Valdez, R.A. and D.W. Speas. 2007. A risk assessment model: to evaluate risks and benefits to aquatic resources from selective withdrawal structures on Glen Canyon Dam. U.S. Bureau of Reclamation, Salt Lake City, Utah.

Van Haverbeke, D.R., D.M. Stone, and M.J. Pillow. 2013. Long-term monitoring of an endangered desert fish and factors influencing population dynamics. Journal of Fish and Wildlife Management 4(1): 163–177.

Van Haverbeke, D.R., D.M. Stone, M.J. Dodrill, K.L. Young, and M.J. Pillow. 2017. Population expansion of humpback chub in western Grand Canyon and hypothesized mechanisms. The Southwestern Naturalist 62(4): 285-292.

Van Riper, C., III., J.R. Hatten, J.T. Giermakowski, D. Mattson, J.A. Holmes, M.J. Johnson, E.M. Nowak, K. Ironside, M. Peters, P. Heinrich, K.L. Cole, C. Truettner, and C.R. Schwalbe. 2014. Projecting climate effects on birds and reptiles of the Southwestern United States. U.S. Geological Survey Open-File Report 2014–1050. Available at http://dx.doi.org/10.3133/ofr20141050.

Vinson, M.R., E.C. Dinger, and D.K. Vinson. 2010. Piscicides and invertebrates: After 70 years, does anyone really know? Fisheries 35: 61-71.

Walters, D.M., E. Rosi-Marshall, T.A. Kennedy, W.F. Cross, and C.V. Baxter. 2015. Mercury and selenium accumulation in the Colorado River food web, Grand Canyon, USA. Environmental Toxicology and Chemistry 34(10): 2385–2394.

Ward, D.L. and S.A. Bonar, 2003. Effects of cold water on susceptibility of Age-0 flannelmouth sucker to predation by rainbow trout. The Southwestern Naturalist 48(1): 43–46.

Ward, D.L. 2011. How does temperature affect fish?" presented at Knowledge Assessment II: 2nd Synthesis Workshop with the Grand Canyon Technical Workgroup - Aquatic Resources, October 18–19, Grand Canyon Monitoring and Research Center, Flagstaff, Arizona.

Ward, D.L. 2015. Green sunfish *Lepomis cyanellus*: Risk assessment for the Colorado River ecosystem. Memorandum from D. Ward (GCMRC) to K. Grants (Reclamation), 30 September.

Ward, D.L., R. Morton-Starner, and B. Vaage. 2018. Management brief: Are hatchery-reared rainbow trout and brown trout effective predators on juvenile native fish? In Press. U.S. Geological Survey, Grand Canyon Monitoring and Research Center. Arizona.

Whiting, D.P., C.P. Paukert, B.D. Healy, and J.J. Spurgeon. 2014. Macroinvertebrate prey availability and food web dynamics of nonnative trout in a Colorado River tributary, Grand Canyon. Freshwater Science 33(3): 872–884.

Yackulic, C.B., J Korman, M.D. Yard, and M. Dzul. 2018. Inferring species interactions through joint mark-recapture analysis. Ecology 99: 812-821.

Yackulic, C.B., M.D. Yard, J. Korman, and D.R. Van Haverbeke. 2014. A quantitative life history of endangered humpback chub that spawn in the Little Colorado River: Variation in movement growth and survival. Ecology and Evolution 4(7): 1006–1018.

Yard, M.D., L.G. Coggins, and C.V. Baxter. 2008. Foraging ecology of non-native trout in the Colorado River, Grand Canyon: predation on native fishes and the effects of turbidity. U.S Geological Survey, Powerpoint presentation to the Glen Canyon Dam Adaptive Management Program, Technical Work Group, June 16-17, 2008.

Yard, M.D., L.G. Coggins, C.V. Baxter, G.E. Bennett, and J. Korman. 2011. Trout piscivory in the Colorado River, Grand Canyon: Effects of turbidity, temperature, and fish prey availability. Transactions of the American Fisheries Society 140: 471–486

Yard, M.D., J. Korman, C.J. Walters, and T.A. Kennedy. 2015, Seasonal and spatial patterns of growth of rainbow trout in the Colorado River in Grand Canyon, AZ. Canadian Journal of Fisheries and Aquatic Sciences v. (online), http://dx.doi.org/10.1139/cjfas-2015-0102.

Young, K. 2018. Colorado River 30 Mile humpback chub detections. Personal Communication.

APPPENDIX A – CONCURRENCES

This appendix contains our concurrences with your "may affect, not likely to adversely affect" determinations for the threatened Mexican spotted owl (*Strix occidentalis lucida*) and critical habitat), endangered southwestern willow flycatcher (*Empidonax traillii extimus*), endangered California condor (*Gymnogyps californianus*), threatened western yellow-billed cuckoo (*Coccyzus americanus americanus*), and the endangered Yuma Ridgway's rail (*Rallus obsoletus yumanensis*).

Mexican spotted owl

We concur with your determination that the proposed action may affect, but is not likely to adversely affect the threatened Mexican spotted owl, nor adversely modify critical habitat. We base this concurrence on the following:

- Helicopters will remain at least 1,200 ft from, or at least 1,200 ft above ground level of, any designated Mexican spotted owl protected activity center (PAC). Therefore, use of the helicopters will result in insignificant noise effects to owls occupying habitat beneath the fly routes. No helicopter flights associated with this plan will occur in GCNRA. Primary access to GCNRA locations would be by motor boat. Therefore, the effects would be insignificant and discountable from these activities.

- Additional noise-related effects would be temporary, lasting for the duration of the activity (the hours of equipment operation), and would not occur within 0.25 mile of any known occupied habitat. In addition (and as stated in CM-4) NPS will also use sound dampening measures to reduce the potential for noise disturbance. Based on the limited size, duration, and location of anticipated noise, we think that effects to Mexican spotted owls from additional project-related noise will be insignificant and discountable.

- Actions C1, C2, C3 and C4 involve the use of chemical treatments, including; rotenone, antimycin, potassium permanganate (to neutralize rotenone and antimycin) ammonia, oxygen-level alteration, carbon dioxide or pH altering chemicals, for short durations. Exposure to piscicides from these actions is unlikely given the diet of Mexican spotted owl is primarily made up of small, terrestrial mammals; so owls would not be consuming aquatic species killed by this method. Treatments will be outside of PACs and therefore greatly limits the chance that owls could potentially ingest water in a piscicide treatment area. Additionally, research on toxicity of rotenone to birds indicates that acute toxicity is not possible from field application of rotenone to the prescribed chemical concentration needed to achieve a fish kill. CM-11 measures require formulations and application rates to minimize effects to birds, mammals and invertebrates. Chemical spills could present a risk of greater exposure but standard spill prevention, monitoring, reporting and cleanup procedures would be employed as stated in CM-11. Oxygen-level alteration, carbon-dioxide and pH would be very limited in spatial extent to the immediate treatment area, be short in duration, would be unlikely to cause toxicity to birds through direct or indirect exposure. Chemical treatment is only expected in very limited areas in any given year

(limited to use in tributary segments with natural barriers, and backwaters and off-channel ponds < 5 ac in size). Because it is not likely that owls will be in the vicinity of chemical treatments, the birds do not eat aquatic organisms, and chemical concentrations will be below levels that are toxic to birds, possible impacts of this action are be insignificant and discountable.

- The FWS designated critical habitat for the Mexican spotted owl in 2004 (69 FR 53182, USFWS 2004). Critical habitat for Mexican spotted owl in GCNP includes PACs (30,285 acres) and recovery mixed conifer areas on the North Rim (27,079 acres), totaling 57,364 acres; however, critical habitat does not exist within the action area along the Colorado River corridor. The proposed action does not include any activities that would affect the primary constituent elements of critical habitat; therefore, there will be no effect critical habitat.

The NPS designed conservation measures that avoid and mitigate effects to Mexican spotted owls, pertinent excerpts of these Conservations Measures include:

CM-3

- Prior to the start of project activities for the year, GCNP's Wildlife Department will be contacted for any new information related to Mexican spotted owls near the project area. Sensitive species maps will be updated annually with any new information to ensure consistency with the above measures and will be referenced when annual work plans are developed.

- & Camping will not occur within 0.25mi of PAC boundaries during the breeding season (March 1 – August 31), until surveys can be done to locate nests. Such situations will be coordinated with the GCNP's Wildlife Department.

- & Crews will not exceed 12 people in Mexican spotted owl PACs or suspected occupied areas during the breeding season.

- & To reduce noise impacts on sensitive wildlife and areas with natural or wilderness characteristics when flying to and from the work area, helicopters would maintain a minimum 2,000 ft altitude where possible, per FAA Advisory Circular 91-36D Visual Flight Rules (VFR) Flight Near Noise-Sensitive Areas.

- & Pilots would minimize aircraft use along the rim and cliffs to the greatest extent possible. Helicopter pilots will be encouraged to use quieter maneuvers (ones that produce less noise), wherever possible, according to the Fly Neighborly training available at: https://go.usa.gov/xQPCW and https://www.rotor.org/operations/flyneighborly.aspx

- & In order to minimize noise disturbance within Mexican spotted owl PAC, helicopters will stay at least 1,200 ft (366 m) away from PAC between March 1 and August 31. If non-breeding is inferred or confirmed during approved-protocol surveys in a Protected Activity Center during the breeding season, restrictions on noise disturbances should be relaxed depending on the nature and extent of the proposed disturbance.

- &On a case-specific basis, NPS will assess the potential for noise disturbance to nesting owls. Breeding-season restrictions will be considered if noise levels are estimated to exceed 69 dBA (A-weighted noise level; approximately 80 dBA [owl-weighted noise level, Service 2012]) consistently (i.e., >twice/hour) or for an extended period of time (>1 hr) within 165 ft (50 m) of nesting sites (if known) or within entire Protected Activity Center if nesting sites are not known.

CM-4

- Where possible, pumps, heaters and generators that do not exceed 60 dBA, at 50 ft, will be selected, per the NPS Audio Disturbances rule (36 CFR 2.12).

- &Where possible, boats that do not exceed 75 dBA, at shoreline, will be selected, per the NPS maximum boat noise rule (36 CFR 3.15). Pressure washers will also be selected for action M1 to conform to this noise rule.

- &Where possible crews traveling through riparian areas to get to treatment sites will use established trails and campsites.

CM-11 (Abridged)

- Registered piscicide treatments (C2, C3, or C4):
    - NPS would seek state permits and follow state treatment plan requirements and guidelines. Additionally NPS would follow the NPS approval process and required pesticide use plan. Rotenone or antimycin would be applied in accordance with labels and the appropriate standard operating manuals (Finlayson et al. 2010c, Moore et al. 2008). Formulations and application rates would be selected to minimize potential effects for birds and mammals and minimize toxicity to aquatic invertebrates. These would be used with standard neutralizing agents.

<u>Southwestern willow flycatcher</u>

We concur with your determination that the proposed action may affect, but is not likely to adversely affect the endangered southwestern willow flycatcher. We base this concurrence on the following:

- Effects to southwestern willow flycatcher would be focused on the river/riparian habitat within the action area which constitute the species' potential, suitable and existing breeding areas. As with other bird species, the primary ways in which the proposed action could affect this species would be human-generated noise during the breeding season from humans, mechanical treatments, helicopters or from generators or pumps used for various control actions, potential direct effects from chemical treatments, indirect effects to prey from chemical or mechanical treatments. As stated in CM-4, there are a number of measures to mitigate sound for riparian birds, and as stated in CM-8 there would be periodic surveys for this species and avoidance of suitable breeding habitat during breeding season. No helicopter landing zones will be used in suitable habitat during

breeding season unless a clearance survey in the past year has determined that it is unoccupied. If the area is occupied or NPS is unable to conduct clearance surveys, then either the action will not occur during the breeding season (May 1 – August 31) or NPS will communicate with USFWS Arizona Ecological Services Field Office (AESO) prior to the action to determine an appropriate buffer if there is still a reason to consider going forward in this location during that time. Therefore, these effects would be insignificant and discountable from these activities.

- Additional noise disturbance to southwestern willow flycatcher may result from any of the control actions, particularly those with appreciable noise generation. Noise-related effects would be temporary, lasting for the duration of the activity (the hours of equipment operation), and may result in flushing but would be unlikely to result in nest abandonment or changes in significant behavioral activity or important life requirements such as nesting, roosting, foraging, rearing, and movement activities and habitat. As stated in CM-4, there are a number of measures to mitigate sound for birds. These effects would also be insignificant and discountable.

- Southwestern willow flycatchers are unlikely to be directly affected by most control treatments because actions will be primarily water-based, however some activities may occur near the banks in temporary, un-vegetated, backwaters that may be available depending on river water level/GCD discharge, but sampling could affect some shoreline vegetation (trampling) and cause some noise disturbance. Therefore, CM-8 prescribes periodic surveys for this species and avoidance of suitable breeding habitat during breeding season. Therefore, these effects would be insignificant and discountable from these activities.

- Actions C1, C2, C3 and C4 involve the use of chemical treatments, including; rotenone, antimycin, potassium permanganate (to neutralize rotenone and antimycin) ammonia, oxygen-level alteration, carbon dioxide or pH altering chemicals, for short durations. Southwestern willow flycatchers could potentially consume insects or ingest water exposed to rotenone, however, research on toxicity of rotenone to birds indicates that acute toxicity was not possible from field application of rotenone to achieve a fish kill. CM-11 measures require formulations and application rates to minimize effects to birds, mammals and invertebrates. Chemical spills could present a risk of greater exposure but standard spill prevention, monitoring, reporting and cleanup procedures would be employed as stated in CM-11. Oxygen-level alteration, carbon-dioxide and pH would be very limited in spatial extent to the immediate treatment area, be short in duration, would be unlikely to cause toxicity to birds through direct or indirect exposure. Chemical treatment is only expected in very limited areas in any given year (limited to use in tributary segments with natural barriers, and backwaters and off-channel ponds < 5 ac in size). Any effects would be insignificant and discountable.

Conservation measures that are designed to avoid and mitigate potential harm to southwestern willow flycatcher are outlined in CM-3, CM-4, and CM-8, and pertinent excerpts of these Conservations Measures include;

CM-3

- Sensitive species maps will be updated annually with any new information to ensure consistency with the above measures and will be referenced when annual work plans are developed.

- & To reduce noise impacts on sensitive wildlife and areas with natural or wilderness characteristics when flying to and from the work area, helicopters would maintain a minimum 2,000 ft altitude where possible, per FAA Advisory Circular 91-36D Visual Flight Rules (VFR) Flight Near Noise-Sensitive Areas.

- & Pilots would minimize aircraft use along the rim and cliffs to the greatest extent possible. Helicopter pilots will be encouraged to use quieter maneuvers (ones that produce less noise), wherever possible, according to the Fly Neighborly training available at: https://go.usa.gov/xQPCW and https://www.rotor.org/operations/flyneighborly.aspx

- & No helicopter landing zones will be used in suitable breeding habitat for southwest willow flycatcher during breeding seasons.

CM-4

- Where possible, pumps, heaters and generators that do not exceed 60 dBA, at 50 feet, will be selected, per the NPS Audio Disturbances rule (36 CFR 2.12).

- & Where possible, boats that do not exceed 75 dBA, at shoreline, will be selected, per the NPS maximum boat noise rule (36 CFR 3.15). Pressure washers will also be selected for action M1 to conform to this noise rule.

- & Where possible crews traveling through riparian areas to get to treatment sites will use established trails and campsites.

CM-8

- Surveys of southwestern willow flycatchers through the project area will be conducted periodically (typically every 2 years) as budget allows or in accordance with the Service's 2016 LTEMP Biological Opinion (Service 2016c).

- To ensure that staff have the most current information on flycatchers prior to the start of any management activities under the Proposed Action, the GCNP's wildlife department would be contacted for suitable breeding habitat maps and any new occurrence near the project area.

- Southwestern willow flycatcher location, survey maps, and suitable breeding habitat maps will be updated following any new information to ensure consistency with the above measures and will be referenced when annual work plans are developed.

- Suitable southwestern willow flycatcher breeding habitat, as defined in the Southwestern Willow Flycatcher Recovery Plan (Service 2002a), will be avoided for activities which may cause disturbance including Actions M1 (if using pressure sprayer), P1, P5, C1, C2, C3, C4, and C5 (if using noise generating equipment) during the breeding season (May 1-

August 31). If there is a need to move forward with any of these actions in suitable breeding habitat during breeding season, then clearance surveys for southwestern willow flycatcher will be conducted during breeding season in the immediate action area to determine if it is occupied or unoccupied prior to the action. NPS will conduct clearance surveys as close to the start of the action as possible, preferably within 1-2 days. If the area is occupied or NPS is unable to conduct clearance surveys, then either the action will not occur during the breeding season or NPS will communicate with the Service AESO prior to the action to determine an appropriate buffer if there is still a reason to consider going forward in this location during that time.

- &No helicopter landing zones for this Proposed Action will be used in suitable breeding habitat for southwest willow flycatcher during the breeding season unless a clearance survey in the past year has determined it is unoccupied. If the area is occupied or NPS is unable to conduct clearance surveys, then either the action will not occur during the breeding season or NPS will communicate with AESO prior to the action to determine an appropriate buffer if there is still a reason to consider going forward in this location during that time.

- &No camping or sustained activities would occur by fisheries crews for this proposed action, except at already established campsites, in suitable breeding habitat within the breeding season (May 1 – August 31) and travel through these areas will be minimized during this season.

- Habitat modification of riparian areas in this species' suitable breeding habitat would not occur as part of management activities under the Proposed Action.

CM-11

<u>California condor</u>

We concur with your determination that the proposed action may affect, but is not likely to adversely affect the endangered California condor. We base this concurrence on the following:

- The proposed action includes activities that may attract California condors and result in potential contact with humans. Condors are naturally curious and it is not uncommon for them to be seen frequenting areas of high human activity. The noise and activity associated with management activities has the potential to attract condors to project sites and can increase the potential for interaction between condors and humans. Fisheries crews would generally consist of small groups of up to 4-8 people. Conservation Measures (implemented under past consultations) to educate work crews of condor concerns and to cease activities if condors are present would reduce potential disturbance from management activities to the birds. To date, condors have not been observed near NPS fisheries projects. While California condor nesting and roosting habitat is generally limited to cliffs and caves in the inner canyon, a pair of condors has successfully nested multiple times within Marble Canyon. The activities of the proposed action will take place along the mainstem Colorado River and in tributaries within GCNP and in GCNRA

below the Glen Canyon Dam, near the Marble Canyon nest site. Crews may also need to travel through these areas to get to a project site, however, crews will use established trails and therefore will not contribute measureable disturbance to condors when compared to current conditions. Conservation Measure (CM) 4 includes a number of measures to mitigate sound in general for birds; therefore, these effects would be insignificant and discountable.

- Activities under the Proposed Action have the potential to affect California condors through noise disturbance associated with activity in the vicinity of known condor locations in side canyons as well as helicopter flights carrying live fish, staff, and project equipment. Actions M2, M3, B1, P1, P2, P4, P5, C1, C2, C3, C4 and C5 may require helicopter use. There is potential for direct noise disturbance to condors, however, Conservation Measures to minimize the potential for noise disturbance to condors during the breeding season are listed above as CM-3. These measures are currently implemented at GCNP and have previously been included in other Biological Opinions for the park (Service 2000, 2009c, 2009d, 2012b) and include offsets for helicopter flight paths from known condor nesting and roosting areas to avoid disturbance. There is some, but very low, potential risk of helicopter collisions with condors, though a collision or even a 'near miss' has never occurred in GCNP and are highly unlikely; therefore, these effects would be insignificant and discountable.

- Additional noise disturbance to California condors may result from any of the control actions, particularly those with appreciable noise generation. Noise-related effects would be unlikely, and if occurring they would be temporary, lasting for the duration of the activity (the hours of equipment operation), and would be unlikely to result in nest abandonment or changes in significant behavioral activity or important life requirements such as nesting, roosting, foraging, rearing, and movement activities. As stated in CM-4, there are a number of measures to mitigate sound for birds. These effects would also be insignificant and discountable.

- Actions C1, C2, C3 and C4 involve the use of chemical treatments, including; rotenone, antimycin, potassium permanganate (to neutralize rotenone and antimycin) ammonia, oxygen-level alteration, carbon dioxide or pH altering chemicals, for short durations. Exposure to piscicides from these actions is unlikely given the diet of Mexican spotted owl is primarily made up of small, terrestrial mammals; so birds would not be consuming aquatic species killed by this method. Treatments will be outside of PACs and therefore greatly limits the chance that owls could potentially ingest water in a piscicide treatment area. Additionally, research on toxicity of rotenone to birds indicates that acute toxicity is not possible from field application of rotenone to the prescribed chemical concentration needed to achieve a fish kill. CM-11 measures require formulations and application rates to minimize effects to birds, mammals and invertebrates. Chemical spills could present a risk of greater exposure but standard spill prevention, monitoring, reporting and cleanup procedures would be employed as stated in CM-11. Oxygen-level alteration, carbon-dioxide and pH would be very limited in spatial extent to the immediate treatment area, be short in duration, would be unlikely to cause toxicity to birds through direct or indirect

exposure. Chemical treatment is only expected in very limited areas in any given year (limited to use in tributary segments with natural barriers, and backwaters and off-channel ponds < 5 ac in size). Because it is not likely that owls will be in the vicinity of chemical treatments, the birds do not eat aquatic organisms, and chemical concentrations will be below levels that are toxic to birds, possible impacts of this action are be insignificant and discountable.

Conservation measures that are designed to avoid and mitigate potential harm to California condors are outlined in CM-3 and CM-4, and pertinent excerpts of these Conservations Measures include;

CM-3

- Prior to the start of project activities for the year, GCNP's Wildlife Department will be contacted for any new information related to California condors near the project area. Sensitive species maps will be updated annually with any new information to ensure consistency with the above measures and will be referenced when annual work plans are developed.

- & Any crew access necessary within 0.25 mi of an active condor nest site during the breeding season will be limited to established roads and trails. If access off designated roads or trails or camping is necessary during the breeding season, only activities that occur greater than 0.25 mi from any known or suspected nest area may be conducted. Such situations will be coordinated with GCNP's Wildlife Department.

- & Planned projects involving mechanized equipment will not occur within 0.5 mi of active condor nesting sites during the breeding season (February 1 – September 30).

- & To reduce noise impacts on sensitive wildlife and areas with natural or wilderness characteristics when flying to and from the work area, helicopters would maintain a minimum 2,000 ft altitude where possible, per FAA Advisory Circular 91-36D Visual Flight Rules (VFR) Flight Near Noise-Sensitive Areas.

- & Flights would occur prior to 10 am whenever possible because condors are less active in the morning hours.

- & Pilots would minimize aircraft use along the rim and cliffs to the greatest extent possible. Helicopter pilots will be encouraged to use quieter maneuvers (ones that produce less noise), wherever possible, according to the Fly Neighborly training available at: https://go.usa.gov/xQPCW and https://www.rotor.org/operations/flyneighborly.aspx

- & Aircraft associated with this project would stay at least 1 mi (1.6 km) away from active condor nest locations and vicinities except when human safety would be compromised. The active nesting season is February 1 – September 30. These dates may be modified based on the most current information regarding condor nesting activities (roosting,

fledging, etc.) and coordination with GCNP's Wildlife Program Manager, Section 7 Coordinator, and the Service.

- Helicopters will stay at least 1,200 ft (366 m) away from condors in the air, or on the ground or cliffs unless safety concerns override this restriction.

- If airborne condors approach aircraft, aircraft will give up airspace to the extent possible, as long as this action does not jeopardize safety.

CM-4

- Where possible, pumps, heaters and generators that do not exceed 60 dBA, at 50 feet, will be selected, per the NPS Audio Disturbances rule (36 CFR 2.12).

- Where possible, boats that do not exceed 75 dBA, at shoreline, will be selected, per the NPS maximum boat noise rule (36 CFR 3.15). Pressure washers will also be selected for action M1 to conform to this noise rule.

- Where possible crews traveling through riparian areas to get to treatment sites will use established trails and campsites.

Western yellow-billed cuckoo

We concur with your determination that the proposed action may affect, but is not likely to adversely affect the threatened western yellow-billed cuckoo. We base this concurrence on the following:

- Effects to yellow-billed cuckoo would be focused on the river/riparian habitat within the action area which constitute the species' potential, suitable and existing breeding areas. As with other bird species, the primary ways in which the proposed action could affect this species would be human-generated noise during the breeding season from humans, mechanical treatments, helicopters or from generators or pumps used for various control actions, potential direct effects from chemical treatments, indirect effects to prey from chemical or mechanical treatments. As stated in CM-4, there are a number of measures to mitigate sound for riparian birds, and as stated in CM-8 there would be periodic surveys for this species and avoidance of suitable breeding habitat during breeding season. No helicopter landing zones will be used in suitable habitat during breeding season unless a clearance survey in the past year has determined that it is unoccupied. If the area is occupied or NPS is unable to conduct clearance surveys, then either the action will not occur during the breeding season or NPS will communicate with USFWS Arizona Ecological Services Field Office (AESO) prior to the action to determine an appropriate buffer if there is still a reason to consider going forward in this location during that time. Therefore, these effects would be insignificant and discountable from these activities.

- Additional noise disturbance to yellow-billed cuckoo may result from any of the control actions, particularly those with appreciable noise generation. Noise-related effects would

be temporary, lasting for the duration of the activity (the hours of equipment operation), and may result in flushing but would be unlikely to result in nest abandonment or changes in significant behavioral activity or important life requirements such as nesting, roosting, foraging, rearing, and movement activities and habitat. As stated in CM-4, there are a number of measures to mitigate sound for birds. These effects would also be insignificant and discountable.

- Yellow-billed cuckoos are unlikely to be directly affected by most control treatments because actions will be primarily water-based, however some activities may occur near the banks in temporary, un-vegetated, backwaters that may be available depending on river water level/GCD discharge, but sampling could affect some shoreline vegetation (trampling) and cause some noise disturbance. Therefore, CM-8 prescribes periodic surveys for this species and avoidance of suitable breeding habitat during breeding season. Therefore, these effects would be insignificant and discountable from these activities.

- Actions C1, C2, C3 and C4 involve the use of chemical treatments, including; rotenone, antimycin, potassium permanganate (to neutralize rotenone and antimycin) ammonia, oxygen-level alteration, carbon dioxide or pH altering chemicals, for short durations. Southwestern willow flycatchers could potentially consume insects or ingest water exposed to rotenone, however, research on toxicity of rotenone to birds indicates that acute toxicity was not possible from field application of rotenone to achieve a fish kill. CM-11 measures require formulations and application rates to minimize effects to birds, mammals and invertebrates. Chemical spills could present a risk of greater exposure but standard spill prevention, monitoring, reporting and cleanup procedures would be employed as stated in CM-11. Oxygen-level alteration, carbon-dioxide and pH would be very limited in spatial extent to the immediate treatment area, be short in duration, would be unlikely to cause toxicity to birds through direct or indirect exposure. Chemical treatment is only expected in very limited areas in any given year (limited to use in tributary segments with natural barriers, and backwaters and off-channel ponds < 5 ac in size). Any effects would be insignificant and discountable.

Conservation measures that are designed to avoid and mitigate potential harm to western yellow-billed cuckoos are outlined in CM-3 and CM-4, and pertinent excerpts of these Conservations Measures include;

CM-3

- Sensitive species maps will be updated annually with any new information to ensure consistency with the above measures and will be referenced when annual work plans are developed.

- & To reduce noise impacts on sensitive wildlife and areas with natural or wilderness characteristics when flying to and from the work area, helicopters would maintain a minimum 2,000 ft altitude where possible, per FAA Advisory Circular 91-36D Visual Flight Rules (VFR) Flight Near Noise-Sensitive Areas.

- & Pilots would minimize aircraft use along the rim and cliffs to the greatest extent possible. Helicopter pilots will be encouraged to use quieter maneuvers (ones that produce less noise), wherever possible, according to the Fly Neighborly training available at: https://go.usa.gov/xQPCW and https://www.rotor.org/operations/flyneighborly.asp

- & No helicopter landing zones will be used in suitable breeding habitat for western yellow-billed cuckoo during their breeding season.

CM-4

- Where possible, pumps, heaters and generators that do not exceed 60 dBA, at 50 feet, will be selected, per the NPS Audio Disturbances rule (36 CFR 2.12).

- & Where possible, boats that do not exceed 75 dBA, at shoreline, will be selected, per the NPS maximum boat noise rule (36 CFR 3.15). Pressure washers will also be selected for action M1 to conform to this noise rule.

- & Where possible crews traveling through riparian areas to get to treatment sites will use established trails and campsites.

CM-10

- As funding allows, GCNP would conduct surveys through the project area for the western yellow-billed cuckoo, typically every 3 years. Such surveys may be combined with surveys for other breeding birds and/or southwestern willow flycatchers.

- & To ensure that staff have the most current information on cuckoos prior to the start of any management activities under the Proposed Action, GCNP's wildlife department would be contacted for suitable breeding habitat maps and any new occurrence near the project area.

- & Western yellow-billed cuckoo locations, survey maps, and suitable breeding habitat maps will be updated following any new information to ensure consistency with the above measures and will be referenced when annual work plans are developed.

- & Suitable western yellow-billed cuckoo breeding habitat will be avoided for activities which may cause disturbance including Actions M1 (if using pressure sprayer), P1, P5, C1, C2, C3, C4, and C5 (if using noise generating equipment) during the breeding season (May 15 – September 15. If there is a need to move forward with any of these actions in suitable breeding habitat during breeding season, then clearance surveys for the cuckoo will be conducted during breeding season in the immediate action area to determine if it is occupied or unoccupied prior to the action. NPS will conduct clearance surveys as close to the start of the action as possible, preferably within 1-2 days. If the area is occupied or NPS is unable to conduct clearance surveys, then either the action will not occur during the breeding season or NPS will communicate with the Service AESO prior to the action to determine an appropriate buffer if there is still a reason to consider going forward in this location during that time.

- & No helicopter landing zones for this proposed action will be used in suitable breeding habitat for cuckoos during the breeding season (May 15 – September 15) unless a clearance survey in the past year has determined it is unoccupied. If the area is occupied or NPS is unable to conduct clearance surveys, then either the action will not occur during the breeding season or NPS will communicate with the Service AESO prior to the action to determine an appropriate buffer if there is still a reason to consider going forward in this location during that time.

- & No camping or sustained activities would occur by fisheries crews for this proposed action, except at already established campsites, in suitable breeding habitat within the breeding season (May 15 – September 15) and travel through these areas will be minimized during this season.

- & Habitat modification of riparian areas in this species' suitable breeding habitat would not occur as part of management activities under the Proposed Action.

Yuma Ridgway's rail

We concur with your determination that the proposed action may affect, but is not likely to adversely affect the endangered Yuma Ridgway's rail. We base this concurrence on the following:

- Effects to the Yuma Ridgway's rail would be focused on the river/riparian habitat within the action area which constitute the species' potential, suitable and existing breeding areas. Marsh habitat is very limited in the action area and rails have only been detected a couple of times. As with other bird species, the primary ways in which the proposed action could affect this species would be human-generated noise during the breeding season from humans, mechanical treatments, helicopters or from generators or pumps used for various control actions, potential direct effects from chemical treatments, indirect effects to prey from chemical or mechanical treatments. As stated in CM-4, there are a number of measures to mitigate sound for riparian birds, and as stated in CM-8 there would be periodic surveys for this species and avoidance of suitable breeding habitat during breeding season. No helicopter landing zones will be used in suitable habitat during breeding season unless a clearance survey in the past year has determined that it is unoccupied. If the area is occupied or NPS is unable to conduct clearance surveys, then either the action will not occur during the breeding season or NPS will communicate with USFWS Arizona Ecological Services Field Office (AESO) prior to the action to determine an appropriate buffer if there is still a reason to consider going forward in this location during that time. Therefore, these effects would be insignificant and discountable from these activities.

- Additional noise disturbance to rails, if present, and may result from any of the control actions, particularly those with appreciable noise generation. Noise-related effects would be temporary, lasting for the duration of the activity (the hours of equipment operation), and may result in flushing but would be unlikely to result in nest abandonment or changes in significant behavioral activity or important life requirements such as nesting,

roosting, foraging, rearing, and movement activities and habitat. As stated in CM-4, there are a number of measures to mitigate sound for birds. These effects would also be insignificant and discountable.

- Yuma Ridgway's rails are unlikely to be directly affected by most control treatments because rails are unlikely to be in the action area, and actions will be primarily water-based, however some activities may occur near the banks in temporary, un-vegetated, backwaters that may be available depending on river water level/GCD discharge, but sampling could effect some shoreline vegetation (trampling) and cause some noise disturbance. Therefore, CM-8 prescribes periodic surveys for this species and avoidance of suitable breeding habitat during breeding season. Therefore, these effects would be insignificant and discountable from these activities.

- Actions C1, C2, C3 and C4 involve the use of chemical treatments, including; rotenone, antimycin, potassium permanganate (to neutralize rotenone and antimycin) ammonia, oxygen-level alteration, carbon dioxide or pH altering chemicals, for short durations. Research on toxicity of rotenone to birds indicates that acute toxicity was not possible from field application of rotenone to achieve a fish kill. CM-11 measures require formulations and application rates to minimize effects to birds, mammals and invertebrates. Chemical spills could present a risk of greater exposure but standard spill prevention, monitoring, reporting and cleanup procedures would be employed as stated in CM-11. Oxygen-level alteration, carbon-dioxide and pH would be very limited in spatial extent to the immediate treatment area, be short in duration, would be unlikely to cause toxicity to birds through direct or indirect exposure. Chemical treatment is only expected in very limited areas in any given year (limited to use in tributary segments with natural barriers, and backwaters and off-channel ponds < 5 ac in size). Any effects would be insignificant and discountable.

- Some control actions could remove a source of food for the rail. Non-native crayfish, which currently make up a large portion of the food base for this species, could be targeted for control in certain areas under the proposed action. However chemical treatment is only expected in very limited areas in any given year (limited to use in tributary segments with natural barriers, and backwaters and off-channel ponds < 5 ac in size). Mechanical removal efforts would also be limited in space and time, especially if targeting non-native crayfish. Also, the removal of non-native fish from certain areas could result in increased abundance of native amphibians and aquatic invertebrates, thereby potentially boosting these food sources for this species, which is what they used to depend on more in the past (LCR MSCP 2008). Therefore, indirect effects to birds from food sources would be insignificant and discountable.

Conservation measures that are designed to avoid and mitigate potential harm to Yuma Ridgway's rails are outlined in CM-3 CM-4, and CM-9, and pertinent excerpts of these Conservations Measures include;

CM-3

- Sensitive species maps will be updated annually with any new information to ensure consistency with the above measures and will be referenced when annual work plans are developed.

- & To reduce noise impacts on sensitive wildlife and areas with natural or wilderness characteristics when flying to and from the work area, helicopters would maintain a minimum 2,000 ft altitude where possible, per FAA Advisory Circular 91-36D Visual Flight Rules (VFR) Flight Near Noise-Sensitive Areas.

- & Pilots would minimize aircraft use along the rim and cliffs to the greatest extent possible. Helicopter pilots will be encouraged to use quieter maneuvers (ones that produce less noise), wherever possible, according to the Fly Neighborly training available at: https://go.usa.gov/xQPCW and https://www.rotor.org/operations/flyneighborly.aspx

- & No helicopter landing zones will be used in suitable breeding habitat for Yuma Ridgway's (Yuma Clapper) rail during their breeding season.

CM-4

- Where possible, pumps, heaters and generators that do not exceed 60 dBA, at 50 feet, will be selected, per the NPS Audio Disturbances rule (36 CFR 2.12).

- & Where possible, boats that do not exceed 75 dBA, at shoreline, will be selected, per the NPS maximum boat noise rule (36 CFR 3.15). Pressure washers will also be selected for action M1 to conform to this noise rule.

- & Where possible crews traveling through riparian areas to get to treatment sites will use established trails and campsites.

CM-9

- Surveys of Ridgway's rail through the project area will be conducted periodically (typically every 3 years) as budget allows or in accordance with the LTEMP biological opinion.

- & To ensure that staff have the most current information on Ridgway's rail prior to the start of any management activities under the Proposed Action, the park's wildlife department would be contacted for suitable breeding habitat maps any new occurrence near the project area.

- & Ridgway rail locations, survey maps, and suitable breeding habitat will be updated following any new information to ensure consistency with the above measures and will be referenced when annual work plans are developed.

- & Suitable breeding habitat will be avoided for activities which may cause disturbance including Actions M1 (if using pressure sprayer), P1, P5, C1, C2, C3, C4 and C5 (if using noise generating equipment) during the breeding season (March 1-July 1). If there is a

need to move forward with any of these actions in suitable breeding habitat during breeding season, then clearance surveys for the rail will be conducted during breeding season in the immediate action area to determine if it is occupied or unoccupied prior to the action. NPS will conduct clearance surveys as close to the start of the action as possible, preferably within 1-2 days. If the area is occupied, then either the action will not occur during the breeding season or NPS will communicate with the Service prior to the action if there is still a reason to consider moving forward in this location and during that time.

- No helicopter landing zones for this proposed action will be used in suitable breeding habitat for Ridgway rail during the breeding season (March 1-July 1) unless a clearance survey in the past year has determined it is unoccupied. If the area is occupied or NPS is unable to conduct clearance surveys, then either the action will not occur during the breeding season or NPS will communicate with the Service AESO prior to the action to determine an appropriate buffer if there is still a reason to consider going forward in this location during that time.

- No camping or sustained activities would occur by fisheries crews for this proposed action, except at already established campsites, in suitable breeding habitat within the breeding season (May 1 – August 31) and travel through these areas will be minimized during this season especially in dense riparian vegetation where cattails and/or bulrush are present.

- Habitat modification of riparian areas in this species' suitable breeding habitat would not occur as part of management activities under the Proposed Action.

APPENDIX B: DESCRIPTION OF ESTIMATED BROWN TROUT MOVEMENT AND PREDATION OF HUMPBACK CHUB

To estimate anticipated consumption of humpback chub by stocked yy-male brown trout we modified a model that was developed for stocking rainbow trout into Lees Ferry. This model was developed in cooperation with the U.S. Geological Survey, Grand Canyon Monitoring and Research Center, and modified by NPS. For the modeling, it was assumed that 5,000 adult YY-male brown trout would be stocked into the Glen Canyon reach during each of the first 10 years of a 20-year period (Table 3). The estimated range of input values for 3-month brown trout survival rate, 3-month rate of brown trout movement from the Glen Canyon reach to the Little Colorado River reach, and number of humpback chub eaten by an individual brown trout over a 3-month period were used to estimate effects under low-, moderate-, and high-risk scenarios (Table 3).

In the previous model it was assumed the 3-month per capita predation rate of humpback chub by a rainbow trout was estimated to range from approximately 0.4 to 1.5 humpback chub per rainbow trout, with a median value of about 0.8 humpback chub per rainbow trout. Using an assumption that brown trout are approximately 17 times more piscivorous on humpback chub than a rainbow trout (Yard et al. 2011), it was estimated that the 3-month per capita predation rate of humpback chub by a brown trout could range from approximately 6.8 to 25.5 humpback chub per brown trout, with a median value of about 13.6 humpback chub per brown trout (Table 3). The model assumed a quarterly (three-month) time step and was run over five years. In each time step, the model keeps track of the number of brown trout in the Lees Ferry reach, $N_t^{RBT,LF}$, the number of brown trout in the 30-mile aggregation, $N_t^{RBT,30}$, the number of brown trout in the Little Colorado River (LCR) aggregation, $N_t^{RBT,LCR}$, the cumulative number of juvenile humpback chub eaten in the 30-mile aggregation, $N_t^{HBC,30}$, and the cumulative number of juvenile humpback chub eaten in the LCR aggregation, $N_t^{HBC,LCR}$. In the first time step (i.e., at t=0), all of these values are set equal to zero except $N_t^{RBT,LF}$, which is determined by the number of stocked YY-male brown trout. In subsequent time steps, values are updated according to the following equations:

$$N_{t+1}^{RBT,LF} = N_t^{RBT,LF}(1 - \phi_{30} - \phi_{LCR})\varphi$$
$$N_{t+1}^{RBT,30} = (N_t^{RBT,LF}\phi_{30} + N_t^{RBT,30})\varphi$$
$$N_{t+1}^{RBT,LCR} = (N_t^{RBT,LF}\phi_{LCR} + N_t^{RBT,LCR})\varphi$$
$$N_{t+1}^{HBC,30} = N_t^{HBC,30} + N_t^{RBT,30}\rho_{30}$$
$$N_{t+1}^{HBC,LCR} = N_t^{HBC,LCR} + N_t^{RBT,LCR}\rho_{LCR}$$

Where ϕ_{30} is the three-month movement rate of brown trout from Lees Ferry to 30-mile, ϕ_{LCR} is the three-month movement rate of brown trout from Lees Ferry to the LCR aggregation, φ is the three-month survival rate of stocked brown trout, ρ_{30} is the number of juvenile chub eaten per rainbow trout in the 30-mile aggregation, and ρ_{LCR} is the number of juvenile chub eaten per brown trout in the LCR aggregation. Take at either 30-mile or the LCR aggregation was given by $N_8^{HBC,30}$ and $N_8^{HBC,LCR}$ respectively. Interestingly, we found that take at 30-mile was generally lower even though the expected number of brown trout there was greater because there are many fewer juvenile humpback chub at 30-mile (i.e., even though $\phi_{30} > \phi_{LCR}, \rho_{LCR} \gg \rho_{30}$). We

considered low- and high-end values for each parameter when calculating to give a range of possible outcomes; however, high end values were used for the immigration rate, the intermediate value was used for predation, and the low end value was used for immigration rate in the final reporting in this Biological Opinion in order to analyze the most impactful scenario to make a determination of take and jeopardy, which is necessary to the section 7 consultation. For more information, on parameters and associated derivation and application of this model to brown trout, see the Table 1 below.

Table 1. Calculations used for YY male Brown trout Distribution Model. Parameters for spreadsheet model

Stocked	Starting estimates and citation	Value for calculation
3-month survival (φ)	Korman 2016 (~0.55 annual time scale – 0.85 on 3-month time scale)	We used 0.05 on an annual time scale (0.48 on a 3-month scale) as likely high end value (0.02 is plausible, but potentially too low as many of the studies being cited were not dealing with movement out of the study reach. Did not use higher end estimate based on naturally reproducing trout in the system, as we agree with Department's general argument that survival will be lower for stocked fish.)
3-month movement to LCR (ϕ_{LCR})	Emigration rate (Korman 2015)	Emigration rate (Korman 2015)
3-month per capita effect of brown trout on juvenile chub at LCR (ρ_{LCR})	Modification to Yard 2011 assuming juvenile chub densities are ~ 4x higher now.	Modification to Yard 2011 assuming chub densities are ~ 4x higher now.
3-month movement to 30 mile (ϕ_{30})	Emigration rate (mean estimate from Korman 2015)	Emigration rate (Mean estimated from Korman 2015)
3-month per capita effect of brown trout on juvenile chub at 30-mile (ρ_{30})	(rate modified from LCR, based on ratio of chub abundance at 30-mile to LCR – see below)	Multiply ρ_{LCR} by ratio of chub abundance at 30-mile to LCR.
Ratio of Chub abundance at 30-mile to LCR	Expert Opinion explanation to the right.	Expert opinion. Calculated relative catch rates for two aggregations and relative spatial extents, and used to estimate ratio of abundances between aggregations.

Table 2. Summary of Quantities used in calculation.

Brown trout stocked	User inputs. 5,000 stocked YY male brown trout.
Brown trout at Lees Ferry	Updates BNT remaining at Lees Ferry after each quarter based on survival and movement rates.
Brown trout at LCR	Updates BNT that move to and survive at LCR after each quarter based on survival and movement rates.

Brown trout stocked	User inputs. 5,000 stocked YY male brown trout.
LCR chub eaten	Running sum of chub in the LCR calculated to have been consumed by stocked brown trout. Rounded number in larger font to the left (closer to parameters) is the total consumed over 2 years.
Brown trout at 30-miles	Updates brown trout that move to and survive at 30-mile after each quarter based on survival and movement rates.
30-mile chub eaten	Running sum of chub at 30-mile aggregation calculated to have been consumed by stocked brown. Rounded number in larger font to the left (closer to parameters) is the total consumed over 2 years.
Total chub eaten per year	Sum of total chub consumed at 30-mile and LCR.

Table 3. Modified model including inputs for three risk level assessments.

Parameter	Low-Risk	Moderate-Risk	High-Risk
Number of YY-male brown trout stocked[a]	5,000	5,000	5,000
3-month brown trout survival rate	0.38	0.62[b]	0.85
3-month proportion of stocked brown trout moving from Glen Canyon reach to Little Colorado River reach[c]	0.0008	0.0008	0.0008
3-month effect on humpback chub at Little Colorado River[d]	6.8	13.6	25.5

[a] Number of YY-male brown trout stocked annually during initial 10 year period; same for all risk levels.

[b] Moderate-risk value calculated as midpoint of low- and high-risk parameter values

[c] Four times the estimated movement rate to reaches IVa and IVb (Korman et al. 2016) to represent number of brown trout within the entire Little Colorado River reach. The reaches monitored by Korman et al. (2016) represent about 28% of the entire Little Colorado River reach.

[d] Number of humpback chub eaten by an individual brown trout during a 3-month period. Calculated by multiplying low, median, and high per capita predation estimates for rainbow trout by a factor of 17.

The modeled estimates of the annual number of YY-male brown trout in the Glen Canyon and Little Colorado River reaches and humpback chub eaten by stocked YY trout in the Little Colorado River reach during the 20-year period under the various risk scenarios are presented. Modeling indicated that annual stocking of 5,000 adult YY-male brown trout into the Glen Canyon reach for a 10-year period could result in average annual consumption over a 20-year period of 13, 113, and 1,915 juvenile humpback chub for low-, moderate-, and high-risk scenarios, respectively. The model estimated that stocked YY-male brown trout could consume fewer than 30 juvenile humpback chub in any given year under the low-risk scenario and up to 225 juvenile humpback chub under the medium-risk scenario. Under the high-risk scenario, approximately 40-3,800 juvenile humpback chub were estimated to be consumed annually during the 20-year period by YY-male brown trout stocked in the Glen Canyon reach and emigrating to the Little Colorado River confluence.

Estimated YOY humpback chub production in the Little Colorado River ranges from approximately 5,000 to 45,000 per year (Yackulic 2018b). Thus, it is estimated that stocked brown trout could consume 8-76% of the annual humpback chub production in a given year under the high-risk assumptions, 1-5% under the medium-risk assumptions, and 0 to 1% of humpback chub production under the low-risk assumptions.

ATTACHMENT E: PROGRAMMATIC AGREEMENT FOR NHPA 106

'

PROGRAMMATIC AGREEMENT
AMONG
U.S. DEPARTMENT OF THE INTERIOR NATIONAL PARK SERVICE; THE HUALAPAI TRIBAL HISTORIC PRESERVATION OFFICER; THE NAVAJO NATION TRIBAL HISTORIC PRESERVATION OFFICER; THE HOPI TRIBE; THE KAIBAB BAND OF PAIUTE INDIANS; THE PAIUTE INDIAN TRIBE OF UTAH, THE SAN JUAN SOUTHERN PAIUTE TRIBE AND THE PUEBLO OF ZUNI;
AND
THE ARIZONA STATE HISTORIC PRESERVATION OFFICER
REGARDING THE IMPLEMENTATION OF THE
EXPANDED NON-NATIVE AQUATIC SPECIES MANAGEMENT PLAN
WITHIN THE GRAND CANYON NATIONAL PARK AND THE
GLEN CANYON NATIONAL RECREATION AREA

PREAMBLE

Since time immemorial, the Canyons (including Glen, Marble, and Grand) have been an important, sacred place to the Hualapai Indian Tribe, Navajo Nation, Hopi Tribe, Kaibab Band of Paiute Indians, the Paiute Indian Tribe of Utah, the San Juan Southern Paiute Tribe, and the Zuni Tribe of the Zuni Indian Reservation. The establishment of the Grand Canyon National Park and Glen Canyon National Recreation Area resulted in the displacement of Native people and restricted free/traditional access to this sacred place. In spite of the displacement and disassociation from this important place, Native people, through their traditions, continue to maintain a cultural and spiritual connection to this sacred place, and the Canyons continue to be an integral part of their respective individual and collective cultural identity and way of life.

The Canyons do not exist in isolation, but rather, exist and function as an integral part of a larger cultural area (to which Native peoples refer to as homelands). This homeland includes the Colorado River, the Little Colorado River, the Canyons (Glen, Marble, and Grand) and a geographical area that extends beyond the limits of the Undertaking. This area should not be conceptualized merely as multiple discrete or detached archaeological sites, traditional cultural properties, historical properties, and/or sacred places, but rather viewed as interconnected, culturally symbiotic areas of traditional religious and cultural value.

As a result of the past twenty five years of consultation, the National Park Service (NPS) understand that the Native people consider all natural resources to be of cultural significance. This Programmatic Agreement (PA), will recognize, as appropriate, the multiple layers of cultural, social, psychological, physical, and spiritual values, integral to the natural environment according to Native communities.

Native people's cultural-natural symbiotic relationships traditionally are embedded in the landscape (both above and below the surface of land and water) and are germane to the continued survival of their inherent cultural identities. In accordance with DOI Secretarial Order 3342, the NPS acknowledges and respects Native people's views and beliefs of the Canyons, and in the spirit of positive government to government collaboration, the NPS shall continue to consult with Tribes on procedural strategies that involve the preservation of the

'

Tribes' heritage (tangible and intangible) and traditional cultural values.

It is in the spirit of this preamble that the following recitals and stipulations are developed, organized, and implemented by the parties to this Programmatic Agreement.

RECITALS

WHEREAS, the National Park Service (NPS) plans to implement the Expanded Nonnative Aquatic Species Management Plan (NNAP) (the undertaking) pursuant to its authority as the federal land manager with jurisdiction over two NPS units, Grand Canyon National Park (GCNP) and Glen Canyon National Recreation Area (GCNRA), and is responsible for identification, management, and preservation of historic properties under its jurisdiction; and

WHEREAS, both the NNAP and 2013 CFMP provide an adaptive management framework for fisheries and nonnative aquatic species management decisions in the Colorado River and its tributaries within the NPS units from Glen Canyon Dam to the boundary of Lake Mead National Recreation Area over the next twenty (20) years; and

WHEREAS, fisheries management goals for the Colorado River and the Paria River in GCNRA are to maintain a highly valued recreational rainbow trout fishery with minimal emigration of rainbow trout downstream; restore and maintain healthy, self-sustaining native fish communities, native fish habitat, and the important ecological role of native fishes to the extent possible, and prevent further introductions of non-native aquatic species; and

WHEREAS, fisheries management goals for the Colorado River and its tributaries in GCNP are to meet or exceed population and demographic goals for the appropriate recovery unit applicable to the park for existing Endangered Species Act (ESA) listed fish species, maintain self-sustaining populations, and restore the distribution of those species to the extent practicable within the park; maintain or enhance viable populations of existing native fish, restore native fish communities and native fish habitat within GCNP, to the extent practicable; restore self-sustaining populations of extirpated fish species; and prevent further introductions of non-native aquatic species, and remove, when possible, or otherwise contain individuals or populations of non-native species that have already become established within GCNP; and

WHEREAS, although GCNP and GCNRA are managed as independent units of the NPS, they will work together in implementing the management actions outlined in the 2019 NNAP, and will continue to work together on the management actions outlined in the 2013 Comprehensive Fisheries Management Plan (CFMP); and

WHEREAS, NPS, in consultation with the SHPO and Tribes pursuant to 36 CFR Part 800 of the regulations implementing Section 106 of the National Historic Preservation Act (54 USC 306108), have determined that Section 106 requirements can be more effectively and efficiently implemented and delays to procedural exigencies minimized through implementing a programmatic approach stipulating roles and responsibilities, establishing protocols for consultation, facilitating identification and evaluation of historic properties, and streamlining the assessment and resolution of adverse effects; and

'

WHEREAS, NPS and SHPO previously concurred that the Canyons from Glen Canyon Dam to River Mile 277, and the lower gorge of the Little Colorado River, are NRHP-eligible as a Traditional Cultural Property as defined in National Register Bulletin 38 (NPS 1990), under National Register Criteria (a), (b), (c), and (d) (36 CFR 60.4); and

WHEREAS, the Area of Potential Effects (APE) for this undertaking consists of the waters and near shore environment of the mainstem and all tributaries of the Colorado River between Glen Canyon Dam and the Lake Mead inflow, approximately 292 river miles (see Appendix A); and

WHEREAS, NPS, through archeological survey, monitoring, and consultation, has identified historic properties, including properties of traditional religious and cultural importance, located within or partially within the APE; and

WHEREAS, SHPO is authorized to sign and enter this Programmatic Agreement (PA or Agreement) in order to fulfill its role of advising and assisting Federal agencies in carrying out Section 106 responsibilities under the following federal statutes: Sections 101 and 106 of the National Historic Preservation Act of 1966, as amended, 306101 et seq., and pursuant to 36 CFR Part 800, regulations implementing Section 106, at 800(c)(1)(i), and 800.6(b); and

WHEREAS, NPS has determined that specific tools within the NNAP will have an adverse effect, on the Colorado River and its associated elements, as a Register-eligible property of traditional and cultural importance eligible for listing in the National Register of Historic Places under Criteria A and B and has consulted with the SHPO and THPOs pursuant to 36 CFR Part 800; and

WHEREAS, the GCNP traditionally associated tribes include the Hopi Tribe of Arizona; the Havasupai Tribe of Arizona; the Hualapai Tribe of the Hualapai Indian Reservation, Arizona; the Kaibab Band of Paiute Indians of the Kaibab Indian Reservation, Arizona; the Navajo Nation, Arizona, New Mexico, Utah: the San Juan Southern Paiute Tribe of Arizona; the Zuni Tribe of the Zuni Reservation, New Mexico; the Paiute Indian Tribe of Utah; Las Vegas Paiute Tribe of Paiute Indians, Nevada; Moapa Band of Paiute Indians, Nevada and the Yavapai-Apache Nation, Arizona; and

WHEREAS, the GCNRA traditionally associated tribes, in addition to the tribes that are also traditionally associated with GCNP, include the Ute Mountain Ute Tribe, Colorado; and

WHEREAS, the NPS traditionally associated tribes are federally recognized Indian Tribes that attach traditional and cultural significance to the Colorado River and associated elements; and

WHEREAS, NPS received responses and has consulted **with** seven of the associated tribes (collectively Tribes) in the development of this Programmatic Agreement (Agreement) and these Tribes are the Hopi Tribe of Arizona, the Hualapai Indian Tribe of the Hualapai Indian Reservation, Arizona, the Kaibab Band of Paiute Indians of the Kaibab Indian Reservation, Arizona, the Navajo Nation, Arizona, New Mexico & Utah, the Paiute Indian Tribe of Utah, the San Juan Southern Paiute Tribe of Arizona, and the Zuni Tribe of the Zuni Reservation,

'

New Mexico; and

WHEREAS, NPS acknowledges that no provision of this PA will be construed by any of the signatories as abridging or debilitating any sovereign powers of the Tribes, or interfering with the government-to-government trust relationship between the United States and the Tribes; and

WHEREAS, NPS refers to the National Historic Preservation Act of 1966, as amended (NHPA), authorities, which are based on boundaries defined by the Federal Government and do not reflect the Tribes' fundamental connection to the Canyons that extend outside these legally-defined boundaries, and that these connections include lands central to the Tribes' origins, areas of ancestral and ongoing cultural importance to Tribes, places important to the Tribes ongoing stewardship roles in the Canyons, and lands inherently important to Tribes' cultural identities; and

WHEREAS, NPS consulted the Navajo and Hualapai Tribal Historic Preservation Officers (THPO) and the Navajo and Hualapai THPOs are authorized to enter this Agreement in order to fulfill the role of advising and assisting Federal agencies in carrying out Section 106 responsibilities pursuant to 36 CFR § 800.2(c)(1)(ii), and 36 CFR § 800.6(b)(2); and

WHEREAS, the Hualapai Indian Tribe of the Hualapai Indian Reservation is a federally recognized Indian Tribe, which, for the purposes of this Agreement is represented by the Hualapai Tribal Historic Preservation Officer (Hualapai THPO), as provided for under 36 CFR § 800.2(c)(2)(i)(A) and the Hualapai Cultural Resources Ordinance, Resolution No. 13-98; and, because the APE of this Undertaking is located, in part, on Hualapai Indian Reservation, the Hualapai THPO is a Party to this Agreement; and

WHEREAS, the Hualapai Indian Tribe and the Department of the Interior do not agree on the precise location of the boundary between the Hualapai Indian Reservation and Grand Canyon National Park, and this Agreement is not intended to, and shall not be construed to, resolve this disagreement, nor shall it be construed to alter the position of either party with respect to this issue; and

WHEREAS, the Navajo Nation and the Department of the Interior do not agree on the precise location of the boundary between the Navajo Indian Reservation and federal lands administered by Grand Canyon National Park and/or Glen Canyon National Recreation Area and this Agreement is not intended to, and shall not be construed to, resolve this disagreement, nor shall it be construed to alter the position of either party with respect to this issue; and

WHEREAS, the Navajo Nation is a federally recognized Indian Tribe, which, for the purposes of this Agreement is represented by the Navajo Nation Tribal Historic Preservation Officer (Navajo THPO), as provided for under 36 CFR § 800.2(c)(2)(i)(A) and the Navajo Nation Cultural Resources Protection Act (CMY-19-88) and Jischaá Policy; and, because the APE of this Undertaking is located, in part, on Navajo Indian Reservation, the Navajo Nation THPO is a Party to this Agreement; and

WHEREAS, the Navajo Nation views the entire Glen Canyon, Marble Canyon and Grand Canyon as an entire ecosystem complete and inclusive of wildlife, riparian vegetation, humpback chub, rainbow trout fishery, and all other native and nonnative fish found and

studied within the Grand Canyon corridor, and the river system itself is considered an integral component of the cultural landscape from rim-to-rim; and

WHEREAS, Hopi Tribe has identified that the Grand Canyon from rim-to-rim is a Traditional Cultural Property (TCP) of the Hopi Tribe and further, that historic properties of cultural or religious significance to the Hopi Tribe have the potential to be impacted by the Undertaking, and the Hopi Tribe is a Party to this Agreement; and

WHEREAS, the Pueblo of Zuni, in particular, has, through letters to the NPS and the Department of the Interior, identified the native and non-native fish, including all other aquatic life, in the Colorado River as sacred and therefore an important contributing element to their TCP; and

WHEREAS, Zuni Tribal Council resolution M70-2010-C086 states that the Zuni Tribe of the Zuni Indian Reservation "… asserts that the Grand Canyon, from rim-to-rim, and all specific places located therein including the confluence of the Colorado and Little Colorado Rivers, topographic and geologic features, springs, archeological sites, mineral and plant collection areas, and any other places it so identifies as historically, culturally, or spiritually important to the Zuni Tribe within the Grand Canyon must, as a matter of the Federal Government s trust responsibility toward the Zuni Tribe, be assumed by all federal agencies to be eligible for the NRHP", and the Zuni Tribe is a Party to this Agreement; and

WHEREAS, the Kaibab Band of Paiute Indians and the Paiute Indian Tribe of Utah are Parties to this Agreement and have identified the Grand Canyon from rim-to-rim as a TCP of the Southern Paiute people and that places culturally significant and/or sacred to Southern Paiutes have the potential to be impacted by the Undertaking; and

WHEREAS, the San Juan Southern Paiute Tribe of Arizona have identified the lands along the east side of the Colorado River from the San Juan River in southern Utah down to the Little Colorado River in Arizona as ancestral lands of cultural significance, and the San Juan Southern Paiute Tribe is a Party to this Agreement; and

WHEREAS, NPS and Tribes, in the spirit of the Secretarial Order No. 3342, recognize the opportunities for cooperative and collaborative partnerships in the management of federal lands and resources; and

WHEREAS, there are no known effects from the NNAP, as a management plan that identifies a suite of tools that could be used for current and future non-native aquatic species infestations, on the archaeological resources and historical properties within the APE in GCNP or GCNRA; and

WHEREAS, NPS used and coordinated the National Environmental Policy Act (NEPA) public participation requirements to assist in satisfying the public involvement requirements under Section 106 of the NHPA pursuant to 36 CFR § 800.2(d)(1-3); and

WHEREAS, in accordance with 36 CFR Part 800.6(a)(1), the NPS has notified the Advisory

'

Council on Historic Preservation (ACHP) of its determination with specified documentation and the ACHP has chosen not to participate in the consultation pursuant to 36 CFR Part 800.6(a)(1)(iii), and development of this agreement, and the ACHP is not a signatory to this PA: and

WHEREAS, NPS intends this Agreement to replace and supersede, upon its execution, the 2013 "Memorandum of Agreement: Comprehensive Fish Management Plan (2013 MOA), and a summary of outstanding tasks from the 2013 MOA is included in Appendix C; and

WHEREAS, the term "Parties" includes both signatories and invited signatories;

NOW, THEREFORE, the Parties agree that this Agreement shall be implemented in accordance with the following stipulations in order to take into account the effects of the Undertaking on historic properties and to satisfy NPS's Section 106 responsibilities for the implementation of actions of the NNAP and NNAP FONSI.

'

STIPULATIONS

The NPS shall ensure that the following stipulations are carried out:

I. Undertaking

The purpose of the undertaking is to implement an Expanded Nonnative Aquatic Species Management Plan to provide additional tools beyond what is available under the LTEMP and CFMP to allow NPS to prevent, control, minimize, or eradicate potentially harmful non-native aquatic species, and the risk associated with their presence or expansion, within the Colorado River and tributaries within the APE. References to the "Taking of Aquatic Life" refer to the actions that either result in aquatic life being killed as a result of the action (e.g. chemical treatments) or being killed by humans after being collected for management purposes (e.g. by traps, nets, fishing or electrofishing).

Table 1 identifies the specific tools that are proposed. Refer to the full environmental assessment for descriptions of the tools, tiers, triggers, and specified areas where the tools would be considered.

Table 1: Specific Tools and Adaptive Management Actions and Potential Adverse Effect(s). CFR 800.5(a)(2)(i-vii) are noted in Column 4 where applicable.

Action Numbers in NNAP	Tier of Use	Description of Tool/Action	Potential Adverse Effect to Historic Property(s)
Chemical			
C1	**3**	**Overwhelm ecosystem-cycling capabilities (ammonia, oxygen, CO2, pH, etc.)**	**(i)Taking of aquatic life and chemical treatment in TCP**
C2	**3**	**Rapid response application of piscicides**	**(i)Taking of aquatic life and chemical treatment in TCP**
C3	**4**	**Application of registered piscicides for high/very high threat species**	**(i)Taking of aquatic life and chemical treatment in TCP**
C4	**2**	**Application of piscicide for native fishery renovation**	**(i)Taking of aquatic life and chemical treatment in TCP**
C5	**1**	**Application of herbicides on nonnative plants**	**(i)Taking of aquatic life and chemical treatment in TCP**
C6	**1**	**Application of mollusk repellants and non-toxic anti-fouling paints**	**No adverse effect**
Harvest			
H1,	**1**	**Incentivized harvest**	**No adverse effect First-tier tool to minimize taking of aquatic life issues**

'

			and facilitate beneficial use through human consumption
Mechanical			
M1,	**2**	**Mechanical disruption of early life stages**	**(i and v) Taking of aquatic life and equipment operation in TCP**
M2	**1**	**Mechanical Removal**	**(i and v) Use of electrical shock tools in TCP and equipment operation. Tier 1 use facilitates live transport where permitted**
M2	**2, 3**	**Mechanical Removal**	**(i and v) Use of electrical shock equipment and generator operation in TCP. At Tier 2 & 3 level it is used to remove non-target species and collect fish for beneficial use. Rarely lethal to aquatic life in and of itself**
M3	**1**	**Acoustic guiding devices**	**No adverse effect**
M4	**1**	**Mechanical harvesting of nonnative aquatic plants**	**(i and v) Removal method and equipment operation which rarely kills plants – primarily removes biomass overwhelming off-channel ecosystems and native vegetation**
Physical			
P1	**1**	**Short-term dewatering using high volume pumps**	**(iv) Equipment operation that may facilitate live transport, temporarily drains/effects springs in TCP, allows for focused removal of nonnatives**
P2	**1**	**Placement of Selective Weirs**	**No adverse effect, native species may also be excluded from small off-channel areas**
P3	**1**	**Placement of non-selective barriers to Exclude Aquatic Species**	**No adverse effect, native species may also be excluded from small off-channel areas**
P4	**4**	**Dredging at RM -12 to connect sloughs and install water control structure**	**(i and iv) Facilitates water control, may allow**

'

			collection/live transport, temporarily drains small off-channel area and may effect associated seeps/springs in this area of the TCP
P5	**Experimental**	**Experimental Only - Small scale temperature changes in small tributaries**	**(i) Deters cold-water fish from entering/using stream habitats, may cause both target and non-target species to leave, or may lead to mortality if they do not leave**
Biological			
B1	**Experimental**	**Experimental Only – Introduction of YY males as population control**	**(iv) Use of modified fish in TCP**

'

II. **Coordination and Section 106 Consultation**

Coordination with the NPS - Proposed activities that are related to the NNAP.

1. & NPS shall work to implement research and monitoring activities under the NNAP that consider cultural preservation goals. As appropriate, tribal perspectives and concerns will be integrated into the activities. These proposed activities will be reviewed by NPS as appropriate for Section 106 compliance.

2. & NPS shall ensure that NNAP-Proposed activities associated with the Undertaking will be reviewed in accordance with 36 CFR 800.3(a) and 36 CFR 800.3(a)(1) to determine if the NNAP-Proposed activities are the "type of activity that has the potential to cause effects on historic properties" and "if the undertaking is a type of activity that does not have the potential to cause effects on historic properties".

    a)& If NPS determines that an NNAP-Proposed activity associated with the Undertaking will have "No potential to cause effects" to listed, contributing or eligible properties per 36 CFR 800.3(a)(1), no further review under this Agreement is required. NPS shall document the proposed activity in accordance with Stipulation VII (C)(7).

    b) & If NPS determines, that an NNAP-Proposed activity associated with the Undertaking will not have an effect on listed, contributing or eligible properties consistent with a finding of "No Historic Properties Affected" per 36 CFR 800.4(d)(1), such as through avoidance, no further review under this Agreement is required. NPS shall document the proposed activity in accordance with Stipulation VII (C)(8).

    c) & If NPS determines, through consultation with the Parties to this Agreement, that an NNAP-Proposed activity associated with the Undertaking will have an effect on listed, contributing or eligible properties but the effect will not be adverse and is consistent with a finding of "No Adverse Effect" under 36 CFR 800.5(b) and avoidance is not possible, NPS shall provide the Parties to this Agreement an opportunity to review and comment on the proposed activity. To the extent possible, consultations shall be conducted electronically. Parties to this Agreement shall have 30 calendar days from receipt of the review request to review and provide written comments to NPS. NPS shall seek to resolve any identified concerns and shall not authorize any proposed activities until this process is complete. NPS shall document the proposed activity in accordance with Stipulation VII (C)(9).

'

d) & If NPS determines, through consultation with the Parties to this Agreement, that an NNAP-Proposed activity associated with the Undertaking may adversely affect listed, contributing or eligible properties, per 36 CFR 800.6(a) and avoidance is not possible, a Memorandum of Agreement (MOA) and a data recovery plan to mitigate the effect(s) will be developed. NPS shall document the proposed activity in accordance with Stipulation VII (C)(10).

III. Mitigation of Potential Adverse Effects

NPS will:

A. Utilize a tiered, adaptive approach for implementing specific treatments in order to minimize or eliminate potential adverse effects to historic properties identified by Tribes, including the "taking of aquatic life" concern. This approach has been developed based upon both written and oral discussions between Tribes and NPS representatives and is intended to address the concerns of non-native aquatic species expansion in the watersheds of the canyons through use of a set of non-lethal or harvest specific treatments. In most cases the Tier 1 tools are non-lethal or harvest non-native aquatic species in an acceptable manner that allows for beneficial use (e.g., human and/or eagle consumption).

B. Implement a Tiered, "Adaptive Management" approach allowing for periodic updates to the tribes on the efficacy of the lower tiered tools and the trigger points that are indicating that the use of tools in the next tier may be needed. NPS will initiate tribal consultation and tribal input prior to next tier tool implementation.

C. Implement use of incentivized harvest as a primary restoration tool for management of particular "undesirable" fish species (like brown trout) within GCNRA. The use and success of this tool is critical in management of some of the non-native aquatic species in order to allow GCNRA to not be required to use higher tier lethal, mechanical, and chemical tools that are of most concern to tribes. The incentivized harvest tool includes options that may benefit tribal members in the following ways:
    a. Tribal members who fish for "target" species can receive a "Restoration Reward" for each fish caught to help defray travel and equipment costs.

    b. Provide for opportunities for tribal youth, accompanied by tribal elders, to participate in guided fishing trips to the Glen Canyon Reach, thereby enabling transference of knowledge between generations about the valued resources within the TCP area, the teaching of how to fish, and the opportunity to engage with tribal elders about the resources and proper way to harvest and honor the fish collected. These fish will be available for family and community use.

    c. Work collaboratively with tribes on the development of educational information for fishermen to ensure the respectful treatment of aquatic life and encourages beneficial use (e.g. human consumption) of harvested fish.

D. Promote "Beneficial Use", where possible, for all management actions involving the "Taking of aquatic life." This includes extra efforts to collect and preserve the aquatic species being managed for either human consumption or use in a tribal aviary.

E. Seek opportunities individually or in conjunction with other partners to prepare proposals for ethnographic, sociological, psychological or 'cause and effect' studies specific to further comprehend the direct, indirect and cumulative impacts of nonnative aquatic species management actions on traditional cultural properties and practitioners occurring within an identified Traditional Cultural Property. NPS will work closely with the tribes in the preparation of these study proposals, including the theoretical orientation, proposed research methodologies, and qualified researchers that would be considered.

IV. NPS and Tribal Consultation

A. NPS will jointly contact and seek opportunities for formal government-to-government consultations related to this PA and proposed higher tier management actions included in the NNAP which involve tribal government officials, tribal elders and religious leaders, or meetings with the SHPO. At any time SHPO and/or tribes may request more information or a meeting. This includes situations where a rapid response is required that may occur within a 30 to 45 day time period following discovery of a new invasive aquatic species. Individual Tribes may accept or decline these offers of formal consultation in writing.

B. With actions occurring in both GCNP and GCNRA, NPS commits to preparing one joint annual work plan and one annual report in an effort to inform the tribes as new nonnative aquatic species are discovered, new triggers are reached, and tools identified in the next higher tiers are considered and planned for.

C. If any new activities are proposed that are outside the scope of this undertaking, NPS will consult on amending the PA or follow 36 CFR Part 800 consultation process.

D. If any previously unidentified cultural resources are discovered, SHPO and tribes will be notified and invited to consult on eligibility and effect.

E. All definitions of Historic Properties adhere to 36 CFR 800.16 unless otherwise indicated.

V. Confidentiality

Consistent with 54 U.S.C. § 307103 (formerly Section 304 of the NHPA) and 36 CFR §800.11(c), NPS and the SHPO shall withhold from disclosure to the public information about the location, character, or ownership of a historic property if it is determined that disclosure may (1) cause a significant invasion of privacy, (2) risk harm to a historic property, or (3) impede the use of a traditional religious site by practitioners.

VI. Annual Work Plan

A. Each year (by July 31st)) NPS will provide to the SHPO and tribal representatives, by

email, a work plan for actions proposed for the upcoming calendar year for review and comment. The work plan will outline proposed fisheries and nonnative aquatic species activities that are relevant to this PA including monitoring, aquatic species removal, fish translocation, weir installation and operation, changes in Tiers related to nonnative aquatic species management, and potential emergency or rapid response actions.

B. NPS will make every effort to notify the tribes at least 21 days prior to use of rapid response tools from the CFMP or the use of tools in a higher tier of the NNAP that are needed due to new or rapidly evolving threats from nonnative aquatic species that were not anticipated in the annual Work Plan. This will provide opportunities for additional consultations, when requested, and for tribal representatives to observe or participate in these management actions.

C. When planning and preparing budget requests for the annual Work Plan projects, NPS will consider requests of participation from the individual tribes and will submit budget proposals to defray travel costs and salaries of those tribal members assisting (site blessings, offerings, mitigation measures, project assistance) in the operational actions, where funding is available.

VII. Annual Review, Reporting, and Requested Meetings

A. Each year (by July 31st) following the execution of this PA until it expires or is terminated, NPS shall provide all parties to this agreement a summary report detailing the previous year's management actions carried out pursuant to its terms. Such reports shall include any problems encountered and any disputes and objections received related to efforts to carry out the terms of this agreement. Parties to this Agreement will have 30 calendar-days to review the Annual Report and provide comments to NPS.

B. As needed or requested by tribes, GCNP, GCNRA, and SHPO will conduct a joint yearly meeting with the signatories or with specific Tribal Councils to review the agreement and the results of management actions carried out in their respective administrative areas. Previous year and upcoming activities along with proposed uses of higher tiered tools may also be reviewed in this meeting.

C. The Annual Report shall address issues and describe actions and accomplishments over the past year including but not limited to:
   1. Results from the management actions taken on non-native aquatic invasive species
   2. Current status of monitoring and mitigation activities, including data analysis that indicates higher tiered tools may be necessary
   3. A review of any proposed uses of higher tiered tools
   4. Completed sensitivity training for NPS staff and volunteers
   5. Any disputes and objections received and how they were resolved
   6. List of activities determined to have no potential to cause effects on historic properties based on Stipulation II (2)(a)
   7. List of activities determined to have no historic properties affected based on Stipulation II (2)(b)

8. List of activities determined to have no adverse effect on historic properties based on Stipulation II (2)(c).
9. List of activities determined to have an adverse effect on historic properties based on Stipulation II (2)(d)

D. Within 30 calendar-days after any meeting with parties to the agreement, NPS shall provide a written summary of the meeting, including any discussion on proposed actions and how they will be addressed. Parties to this Agreement will have 30 calendar-days to review and comment on the meeting notes.

VIII. Beneficial Use

NPS, to the greatest extent feasible, will properly prepare and preserve euthanized brown trout, and other harvested aquatic species, for beneficial use by the Tribes and/or other identified groups. Beneficial use may be human consumption or consumption by raptors cared for in Tribal aviaries.

IX. Staff Sensitivity Training

NPS will provide annual information and targeted sensitivity training for all staff (including NPS employees, volunteers, and contractors) participating in field work for fisheries and nonnative aquatic species management actions. Training will include information regarding tribal perspectives and sensitivities related to fisheries and nonnative aquatic species management in their respective parks. Tribes will be invited to participate in helping to develop and conduct this annual training program.

X. Tribal Participation

NPS will provide opportunities in their respective administrative areas for tribal participation in research activities if requested by the tribes. This may include tribes taking videos of research activities that will allow them to educate and inform other tribal officials, employees, and tribal members.

XI. Duration

A. Unless terminated under Stipulation IV of this Agreement, the term of this Agreement shall be the same as the 20 year term of the NNAP.

B. At least one year prior to the end of the NNAP, the Parties to this Agreement shall consult to determine whether this Agreement remains satisfactory to continue NPS's Section 106 responsibilities for managing non-native aquatic species below Glen Canyon Dam. If there is agreement, NPS will consult with all parties and revise and update this Agreement through the Amendment process described in Section XII. At the appropriate time, if a new agreement is necessary for NNAP, it will be executed prior to the termination of this Agreement.

C. If an extension of this Agreement's duration for this Undertaking is warranted resulting

'

from an extension of the NNAP, Parties to this Agreement will agree to the time period in writing through the amendment process until such time as this Agreement may be revised and updated. In the event of expiration before completion of all stipulations, NPS shall comply with the 36 CFR Part 800 with regard to undertakings in their respective administrative areas that otherwise would have been covered by this PA.

XII. Amendment

Any Party to this Agreement may propose an amendment in writing to NPS. NPS shall consult with all Parties to this Agreement whenever an amendment is proposed by a Party to this Agreement. This Agreement may be amended when such an amendment is agreed to by all Parties to this Agreement. The amendment will be effective on the date a copy signed by all of the Parties to this Agreement is filed with the ACHP. A copy of the amendment will be provided to all Parties to this Agreement.

XIII. Dispute resolution

Should any Party to this Agreement object, in writing to NPS, at any time to any actions proposed or the manner in which the terms of this Agreement are implemented, NPS shall notify the Parties to this Agreement of the objection and consult with the objecting party to resolve the objection. If NPS determines that such objection cannot be resolved, NPS shall:

A. & Forward all documentation relevant to the dispute, including NPS's proposed resolution, to the ACHP. The ACHP shall provide NPS with its advice on the resolution of the objection within 30 calendar days of receiving adequate documentation. Prior to reaching a final decision on the dispute, NPS shall prepare a written response that takes into account any timely advice or comments regarding the dispute from the ACHP and other Parties to this Agreement, and provide them with a copy of this written response. NPS will then proceed according to its final decision.

B. & If the ACHP does not provide its advice regarding the dispute within the 30 calendar day period, NPS may make a final decision on the dispute and proceed accordingly. Prior to reaching such a final decision, NPS shall prepare a written response that takes into account any timely comments regarding the dispute from the Parties to this Agreement, and provide them and the ACHP with a copy of such written response.

C. & NPS's responsibilities to carry out all other actions subject to the terms of this Agreement that are not the subject of the dispute remain unchanged.

XIV. Termination

A. &If any Party to this Agreement determines that the Agreement should be terminated or that its participation in this Agreement should be terminated, the party shall provide other Parties to this Agreement with a written notification for a 30 calendar-day review explaining the reasons for proposing termination. The terminating party should consult with the other parties to seek an amendment to this Agreement.

'

B. &Should such consultation result in an amendment to this Agreement, NPS, in consultation with the Parties to this Agreement, shall amend this Agreement in accordance with Stipulation XI and the Parties to this Agreement shall carry out the provisions as amended.

D. If an amendment is not agreed upon, each Party to this Agreement may terminate this Agreement, or its participation in this Agreement per 36 CFR § 800.6(c)(8).

E. If this Agreement is terminated, NPS shall comply with the Section 106 process, in accordance with 36 CFR § 800, subpart B, for the Undertaking that would otherwise be subject to this Agreement.

XV. Anti-Deficiency Act

NPS's obligations under this Agreement are subject to the availability of appropriated funds and the stipulations of this Agreement are subject to the provisions of the Anti-Deficiency Act. NPS shall make reasonable and good faith efforts to secure the necessary funds to implement this Agreement in its entirety. If compliance with the Anti-Deficiency Act alters or impairs NPS's ability to implement the stipulations of this Agreement, NPS shall consult with the SHPO and ACHP in accordance with the amendment and termination procedures in Stipulations XVII and XVIII of this Agreement.

XVI. Counterpart Signatures

This PA may be executed in counterparts each of which shall be deemed an original and all of which together shall constitute one and the same instrument.

Execution and implementation of this agreement by NPS and SHPO and implementation of its terms evidence that the NPS has taken into account the effects of this undertaking on historic properties and afforded the ACHP an opportunity to comment.

PROGRAMMATIC AGREEMENT
REGARDING THE IMPLEMENTATION OF THE
EXPANDED NON-NATIVE AQUATIC SPECIES MANAGEMENT PLAN
WITHIN THE GRAND CANYON NATIONAL PARK AND THE
GLEN CANYON NATIONAL RECREATION AREA

SIGNATORIES:

NATIONAL PARK SERVICE – GRAND CANYON NATIONAL PARK

By: Woody Smeck _____ Date: 9.6.19
Woody Smeck, Acting Superintendent
Grand Canyon National Park

PROGRAMMATIC AGREEMENT
REGARDING THE IMPLEMENTATION OF THE
EXPANDED NON-NATIVE AQUATIC SPECIES MANAGEMENT PLAN
WITHIN THE GRAND CANYON NATIONAL PARK AND THE
GLEN CANYON NATIONAL RECREATION AREA

SIGNATORIES:

NATIONAL PARK SERVICE – GLEN CANYON NATIONAL RECREATION AREA

By: _____ Date: 7/6/19

William Shott, Superintendent
Glen Canyon National Recreation Area

NAVAJO NATION

By: _____ Date: 08.07.19
Jonathan Nez, President

By: _____ Date: 6/4/2019
Richard M. Begay, Navajo Nation Historic Preservation Officer

PROGRAMMATIC AGREEMENT
REGARDING THE IMPLEMENTATION OF THE
EXPANDED NON-NATIVE AQUATIC SPECIES MANAGEMENT PLAN
WITHIN THE GRAND CANYON NATIONAL PARK AND THE
GLEN CANYON NATIONAL RECREATION AREA

SIGNATORIES:

HUALAPAI INDIAN TRIBE OF THE HUALAPAI INDIAN RESERVATION

By: _____ Date: 8/12/2019
Damon Clarke, Chairman

By: _____ Date: 8/9/19
Peter Bungart, Hualapai Tribal Historic Preservation Officer

The Great Spirit created Man and Woman in his own image. In doing so, both were created as equals. Both depending on each other in order to survive. Great respect was shown for each other; in doing so, happiness and contentment was achieved then, as it should be now.

The connecting of the Hair makes them one person; for happiness or contentment cannot be achieved without each other.

The Canyons are represented by the purples in the middle ground, where the people were created. These canyons are Sacred, and should be so treated at all times.

The Reservation is pictured to represent the land that is ours, treat it well.

The Reservation is our heritage and the heritage of our children yet unborn. Be good to our land and it will continue to be good to us.

The Sun is the symbol of life, without it nothing is possible – plants don't grow – there will be no life – nothing. The Sun also represents the dawn of the Hualapai people. Through hard work, determination and education, everything is possible and we are assured bigger and brighter days ahead.

The Tracks in the middle represent the coyote and other animals which were here before us.

The Green around the symbol are pine trees, representing our name Hualapai – PEOPLE OF THE TALL PINES –

HUALAPAI TRIBE
OFFICE OF THE CHAIRPERSON
P.O. Box 179 / 941 Hualapai Way • Peach Springs, Arizona 86434
(928) 769-2216 • 1-888-769-2221

Damon R. Clarke, Ed.D
Chairman

Philbert Watahomigie, Sr.
Vice Chairman

Ken Hyde
Glen Canyon NRA & Rainbow Bridge NM
Chief of Science and Resource Management
PO Box 1507
Page, Arizona 86040

August 12, 2019

Dear Mr. Hyde:

Please find attached the signature page from the Hualapai Tribe for the Expanded Nonnative Aquatic Species Management Plan Programmatic Agreement (PA). We note that our signatures to the PA do not necessarily constitute endorsement of any particular management action outlined in the PA, but simply reflects our satisfaction that timely and meaningful consultation will take place as long as the agreement is in effect.

Thank you for your efforts in consulting with the Hualapai tribe. You may contact Peter Bungart, Hualapai Tribal Historic Preservation Officer, at peter.bungart@hualapai-nsn.gov or (928) 769-2223 if you have any questions.

Sincerely,

Dr. Damon Clarke, Chairman
Hualapai Tribal Council

Cc: Peter Bungart
Tribal Historic Preservation Officer

PROGRAMMATIC AGREEMENT
REGARDING THE IMPLEMENTATION OF THE
EXPANDED NON-NATIVE AQUATIC SPECIES MANAGEMENT PLAN
WITHIN THE GRAND CANYON NATIONAL PARK AND THE
GLEN CANYON NATIONAL RECREATION AREA

SIGNATORIES:

HOPI TRIBE

By: _____ Date: _____
Stewart Koyiyumptewa, Cultural Preservation Office Manager

PROGRAMMATIC AGREEMENT
REGARDING THE IMPLEMENTATION OF THE
EXPANDED NON-NATIVE AQUATIC SPECIES MANAGEMENT PLAN
WITHIN THE GRAND CANYON NATIONAL PARK AND THE
GLEN CANYON NATIONAL RECREATION AREA

SIGNATORIES:

KAIBAB BAND OF PAIUTE INDIANS

By: _____ Date: _____
Ona Segundo, Chairwoman

PROGRAMMATIC AGREEMENT
REGARDING THE IMPLEMENTATION OF THE
EXPANDED NON-NATIVE AQUATIC SPECIES MANAGEMENT PLAN
WITHIN THE GRAND CANYON NATIONAL PARK AND THE
GLEN CANYON NATIONAL RECREATION AREA

SIGNATORIES:

SAN JUAN SOUTHERN PAIUTE TRIBE

By: _____ Date: _____
Carlene Yellowhair, President

PUEBLO OF ZUNI

By: _____ Date: 8/25/19

Val R. Panteah, Sr., Governor

Val R. Panteah Sr.
Governor

Carleton R. Bowekaty
Lt. Governor

Virginia R. Chavez
Head Councilwoman

Clyde Yatsattie
Councilman

PUEBLO OF ZUNI
P. O. Box 339
Zuni, New Mexico 87327
1203-B NM State Hwy 53
Phone: (505) 782-7022
Fax: (505) 782-7202
www.ashiwi.org

505-782-7000 MAIN

Arlen P. Quetawki, Sr.
Councilman

Eric Bobelu
Councilman

Ricky R. Penketewa, Sr.
Councilman

Arden Kucate
Councilman

Officially known as the Zuni Tribe of the Zuni Indian Reservation

15 August 2019

Mr. William Shott, Superintendent
Glen Canyon National Recreation Area
National Park Service
P.O. Box 1507
Page, Arizona 86040

RE: Programmatic Agreement Regarding the Implementation of the Expanded Non-Native Aquatic Species Management Plan.

Dear Mr. Shott,

The Pueblo of Zuni has received and reviewed the final version of the Programmatic Agreement among U.S. Department of the Interior National Park Service; The Hualapai Tribal Historic Preservation Officer; The Navajo Nation Tribal Historic Preservation Officer; The Hopi Tribe; The Kaibab Band of Paiute Indians; The Paiute Indian Tribe of Utah, The San Juan Southern Paiute Tribe and The Pueblo of Zuni; and The Arizona State Historic Preservation Officer regarding the Implementation of the Expanded Non-Native Aquatic Species Management Plan.

For over ten years, the Pueblo of Zuni has continually voiced our objection to any management actions that involve the taking of life without sufficient justification within Glen and Grand Canyons. The implementation of any lethal non-native aquatic species management action is contrary to Zuni worldview and environmental ethics. Annual ceremonial activities carried out at Zuni are to ensure adequate rainfall and prosperity for *all life*. As Zuni people, we pray not only for Zuni lands, but for all people and all lands. Our prayers are especially aimed at bringing precipitation to the Southwest.

In order to successfully carry out our prayers, offerings, and ceremonies necessary to ensure rainfall for crops and the prosperity of all life, we must maintain a balance with all parts of the interconnected universe. When federal agencies and others needlessly take life as part of an on-going effort to create, sustain, and manage an idealized, human-made ecosystem it results in creating an imbalance in the natural world; thereby, disrupting the harmony and health of the spiritual realm which disproportionately negatively effects us. As Zunis, we recognize that animals are not merely things, but are sentient beings and may be the re-embodiment of our ancestors. As sentient beings, they have the ability to respond to stimuli and therefore have emotions and can experience both physical and psychological pain and pleasure. As Zunis, we revere all life forms and believe that all wild animals (native and non-native) have the right to life, liberty, and procreation within their natural environments without being unnecessarily harassed by humans.

The Pueblo of Zuni appreciates the tiered approach identified in this programmatic agreement as a means to control non-native aquatic species as a consideration, in part, to the expressed Zuni objections to lethal

management actions; however, the document identifies the continued viability of lethal management tools to address non-native aquatics. Any continued use of lethal management actions by the National Park Service in accordance with this programmatic agreement is antithetical to the Zuni familial and stewardship relationship to aquatic life, a devaluation of the special relationship that the Zuni people have with Glen and Grand Canyons and the Colorado River, and it changes the expression and impression of the Colorado River as a waterway of life to a river of death for the Zuni people.

After much deliberation involving the Zuni Tribal Council, the Lt. Governor, and the Zuni religious leadership, as the Zuni Governor, and on behalf of the Pueblo of Zuni, I am signing this document **in protest** for the stated above reasons; my signing should not be misconstrued as concurrence with the stipulations contained in this document. Rather, the Pueblo of Zuni's participation in this document is for the sole intended purpose of maintaining an open channel of communication, through consultation, with the National Park Service, the Arizona State Historic Preservation Officer, the Hualapai Tribe, Navajo Nation, the Hopi Tribe, the Kaibab Band of Paiute Indians, the Paiute Indian Tribe of Utah, and the San Juan Southern Paiute Tribe.

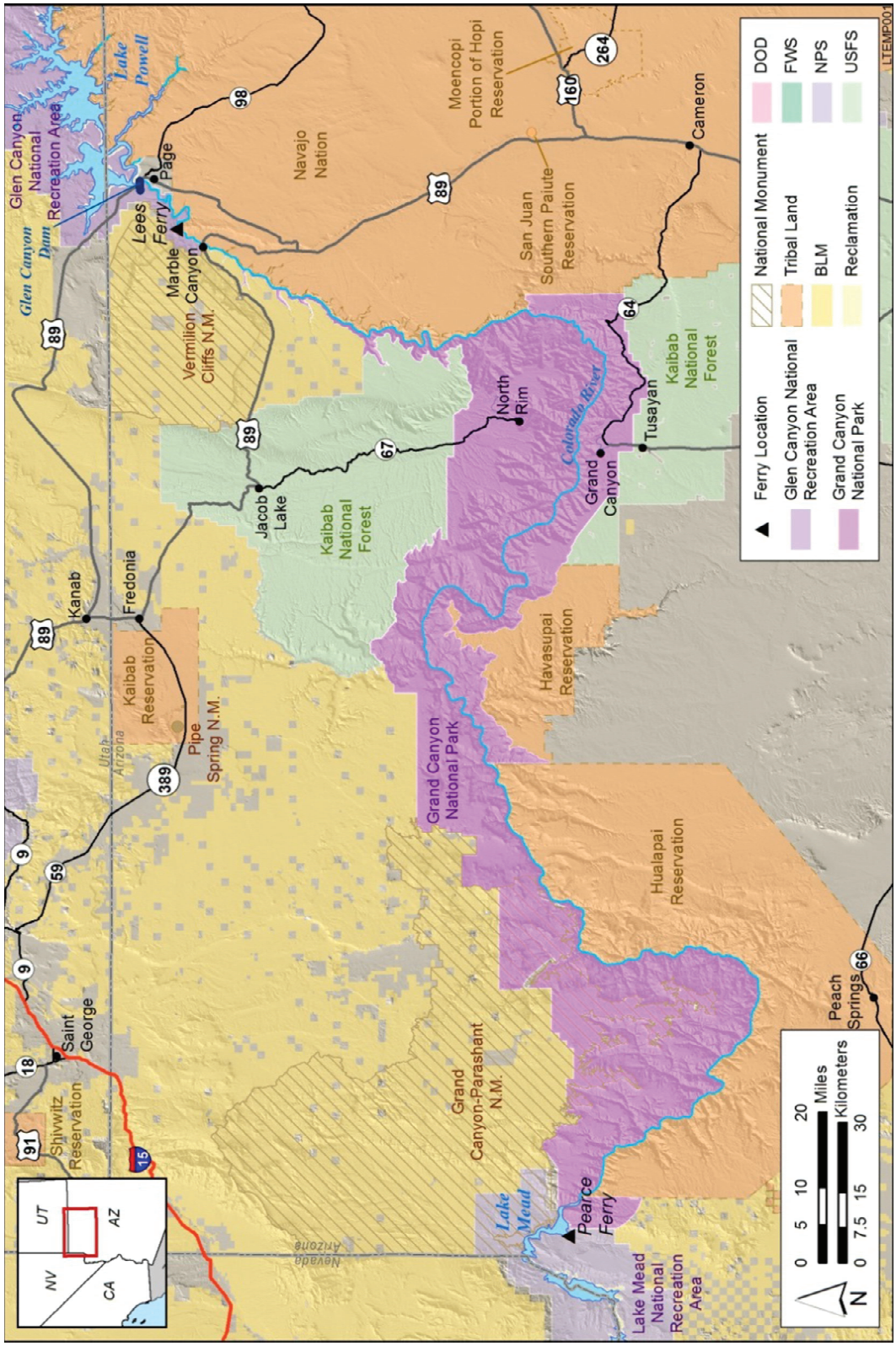
Should you have any questions or need additional information, please contact Kurt Dongoske, Tribal Historic Preservation Officer, at 505.782.4814.

Sincerely,

Val Panteah, Sr.
Governor

Xc: Parties to the Programmatic Agreement via email

APPENDIX A: Map of the Colorado River between Lake Powell and Lake Mead (Map is for illustrative purposes only. The scale does not allow the Area of Potential Effects – the river, tributaries, and near-shore habitats in the project area portions of the Glen, Marble, and Grand canyons) to be



outlined.

'

'

APPENDIX B:

LIST OF STIPULATIONS IDENTIFIED IN THE 2013 COMPREHENSIVE FISH MANAGEMENT PLAN MOA (many are updated in this NNAP PA)

Stipulations

I. NPS and Tribal Consultation

GRCA and GLCA will independently conduct tribal consultation as appropriate to actions in their respective administrative areas.

To be continued. This Stipulation will continue, but is updated under this Agreement.

II. Human Consumption

In GRCA and GLCA to the greatest extent feasible, euthanized trout will be used for human consumption.

To be continued. This Stipulation will continue under this Agreement.

III. Staff Training

GRCA and GLCA will independently provide annual information and training for staff in their respective administrative areas regarding tribal perspectives and sensitivities related to fisheries research and management in GRCA and GLCA. Tribes will be invited to participate.

To be continued. This Stipulation will continue, but is updated under this Agreement.

IV. Tribal Participation

GRCA and GLCA will provide opportunities in their respective administrative areas for tribal participation in research activities if requested by the tribe(s). This may include tribes taking videos of research activities that will allow them to better educate and inform other tribal officials, employees, and tribal members.

To be continued. This Stipulation will continue under this Agreement.

V. Monitoring and Reporting

GRCA and GLCA will be individually responsible for monitoring, reporting, and conducting meetings for their respective administrative areas.

GRCA and GLCA will individually distribute by email copies of relevant fisheries trip reports and technical reports for their respective administrative areas to tribes for their information.

Each year in July, following the execution of this MOA until it expires or is terminated, GRCA and GLCA shall individually provide all parties to this agreement a summary report for their respective administrative areas detailing work carried out pursuant to its terms. Such reports shall include any problems encountered and any disputes and objections received related to efforts to carry out the terms of this agreement.

As needed or requested by tribes, GRCA, GLCA, and SHPO will individually conduct a yearly meeting with the signatories to review the agreement and the results of the program for their activities in their respective administrative areas.

'

As needed or requested by tribes, GRCA, GLCA, and SHPO shall individually host an annual meeting for their respective administrative areas to review yearly activities.

To be continued. This Stipulation will continue, but is updated under this Agreement.