Invasive Fish Species Below Glen Canyon Dam: A Strategic Plan to Prevent, Detect and Respond

Developed by the Smallmouth Bass Ad Hoc Group, through the Technical Work Group of the Glen Canyon Dam Adaptive Management Program in partnership with the Grand Canyon Monitoring and Research Center and the Bureau of Reclamation

Presented to the Glen Canyon Dam Adaptive Management Group
Technical Work Group on January 26, 2023, and accepted by the Adaptive Management Work Group on February 16, 2023.

Executive Summary

This Strategic Plan (Plan) was written in response to the May 2022 Secretary of the Interior's Designee's (Designee) Directive to the Adaptive Management Work Group to provide a plan to '*...prevent, detect, and respond to cool- and warmwater invasive fish establishment below Glen Canyon Dam*'. The Smallmouth Bass Ad Hoc Group was then convened to develop the Plan, as well as discuss the immediate concerns related to smallmouth bass which have been identified as the invasive fish species of most concern to humpback chub recovery and the health of the trout fishery as of fall 2022. To prevent the establishment of invasive fish species in the Colorado River ecosystem (CRe), a combination of long-term, mid-term, and short-term actions will be required. Entrainment through Glen Canyon Dam (GCD) is considered a primary source of invasion. The Lees Ferry reach is expected to be an initial point of establishment. Ultimately, the two approaches to prevent establishment within the Colorado River below GCD are (1) preventing fish passage through GCD, and (2) preventing establishment below the dam.

Long-term actions should include the installation of a fish exclusion device at GCD, while mid-term actions identified in the Plan include targeted flow and temperature changes at GCD. Short-term rapid response actions are meant to be used in the interim to prevent widespread dispersal and establishment, while planning and implementation of mid- and long-term actions are underway. Actions should be implemented as experiments to allow for proper assessment and evaluation. Research and monitoring before, during, and after actions will provide data to evaluate the effectiveness. For example, monitoring for fish entrainment *before* and *after* installation of a fish exclusion device to assess passage through the dam will provide information on the effectiveness of the fish exclusionary device(s). The Glen Canyon Dam Adaptive Management Program (GCDAMP) should maintain the ability to discontinue actions, as the likelihood of success, cost-effectiveness, changing environmental conditions, and the ability to carry out actions may change. Discontinuation of measures (e.g., off-ramping) will require coordination amongst agencies and stakeholders.

To detect new occurrences of invasive fish species in the CRe, it is recommended to expand existing monitoring and conduct additional, targeted monitoring trips. This is described further in Attachment E. If target invasive fish(es) are detected, coordination amongst cooperating fisheries agencies will be necessary. This process is identified in Attachment A. Additional funding and/or reallocation of GCDAMP project priorities will be necessary to support these proposed efforts.

From this Strategic Plan, the GCDAMP stakeholders emphasize the following key takeaways:

(1) Long-term prevention will require limiting fish entrainment into GCD.

(2) Mid-term flow actions are intended to prevent successful spawning of smallmouth bass[1] below GCD.

(3) Short-term rapid response actions may be needed to address newly detected smallmouth bass and other invasive fishes if proposed actions are determined to have a high likelihood of success.

[1] As of December 2022, consideration of smallmouth bass flows are under the Environmental Assessment process at Reclamation, as the current concern is smallmouth bass. However, future flow actions may be necessary in order to address other invasive fish species of concern and this statement should not be limiting of those potential actions.

Contents

Common acronyms in Strategic Plan and Attachments:

AMWG - Adaptive Management Work Group
AZGFD - Arizona Game and Fish Department
CRe - Colorado River Ecosystem
DOI - Department of Interior
GCD - Glen Canyon Dam
GCDAMP - Glen Canyon Dam Adaptive Management Program
GCMRC - Grand Canyon Monitoring and Research Center
LTEMP - Glen Canyon Dam Long-Term Experimental and Management Plan
NPS - National Park Service
ROD - Record of Decision
SMB - Smallmouth bass
TWG - Technical Work Group
USFWS - United States Fish and Wildlife Service
USGS - United States Geological Survey

Definitions:

Cooperating fisheries agencies- science and management agencies who engage in fisheries actions and studies.

Preamble

The goal of this Plan is to create an environment where native fish can thrive. To accomplish this, the long-term, preventative strategies identified in this Plan must be implemented as soon as possible. The members of the Glen Canyon Dam Adaptive Management Program (GCDAMP) Technical Work Group recognize that the terminology, methodology, and contents of this Strategic Plan (hereafter, the Plan) are largely founded on western science principles and do not fully capture the diverse cultural perspectives of the Tribal members of the GCDAMP. For example, there are ongoing issues and concerns regarding the lethal taking of species as a management action and how those actions negatively impact the sanctuary that is the Colorado River within the Grand Canyon (LTEMP FEIS, Ch. 3). These Tribal comments are provided in the Tribal Positions Attachment (Attachment H) in this document.

1.0 Introduction

This Strategic Plan (Plan) was developed in response to the May 18, 2022 Directive from the Secretary of the Interior's Designee (Designee) to the Glen Canyon Dam (GCD) Adaptive Management Work Group (AMWG) to develop a plan to prevent, detect, and respond to cool- and warmwater invasive[2] fish establishment below GCD. For the purposes of this Plan, the geographic scope includes the Colorado River Ecosystem (CRe) as defined by the Glen Canyon Dam Long-Term Experimental and Management Plan (LTEMP) Record of Decision (ROD) as:

"... the Colorado River mainstream corridor and interacting resources in associated riparian and terrace zones, located primarily from the forebay of Glen Canyon Dam to the western boundary of GCNP. The CRe specifically consists of the area where dam operations impact physical, biological, recreational, cultural, and other resources. This section of the river runs through Glen, Marble, and Grand Canyons in Coconino and Mohave Counties in northwestern Arizona."

This Plan was reaffirmed by the Designee's Truths and Proposed Actions presented during the August 2022 AMWG meeting. In addition to responding to the Directive and proposed action, this Plan is intended to help achieve the non-native fish species goal from the LTEMP to '*minimize or reduce the presence and expansion of aquatic non-native invasive species*' (LTEMP ROD). This Plan builds upon National Park Service (NPS) and Arizona Game and Fish Department (AZGFD) management strategies for the CRe and is intended to help coordinate ongoing efforts by the Bureau of Reclamation (Reclamation), such as Reclamation's pursuit of a means to prevent further entrainment and establishment of deleterious invasive non-native fish through GCD (LTEMP BO & Svoboda, 2022). This Plan is not intended to curtail or restrict management agency actions already available under existing planning and compliance.

[2] Invasive fish is defined in Executive Order 131112 – Invasive Species.

The actions and recommendations included in this Plan focus on species considered to be the highest threat to both federally listed and other native fishes throughout the CRe and the Lees Ferry rainbow trout fishery within Glen Canyon. All actions in this Plan are intended to be flexible in order to meet the adaptivity required in responding to invasive fish species as new situations arise, environmental conditions change, and knowledge is gained.

Based on low elevations projected at Lake Powell by the August (2022) 24-Month Study produced by Reclamation, prevention of invasive fish establishment should include long-term preparation for continued low lake elevations and warmer release temperatures. The penstocks are at a fixed elevation of 3470 ft (centerline), and as lake levels drop, the depth to penstocks decreases. For example, during low elevations in April 2022, the top of the penstocks was only 41 ft below the surface. This results in increased thermal suitability for warmwater fishes downstream of GCD, and likely increased rates of fish entrainment and passage.

To address this problem, a multi-faceted approach is required in order to be most effective. This includes:

(1) the long-term placement of a fish exclusionary device(s) to reduce further entrainment (non-flow actions),

(2) mid-term operational flow options which utilize the dam to change temperature and/or velocity to prevent and/or reduce reproductive success and limit establishment of fish that have already passed through the dam, and

(3) short-term rapid response actions to remove invasive fishes to protect Lees Ferry, the mainstem and its tributaries from further establishment (non-flow actions).

It is also important to consider actions that may provide long-term reduction in the risk of entrainment of cool- and warm-water invasive species below GCD, but are outside the scope of this Plan (Attachment F). To be successful, all actions must be strategically orchestrated and cohesive. These actions and their necessity are detailed in Section 3.3 Prevention and Response Actions.

2.0 Guiding Principles

Several principles were considered to help guide the creation of this Plan:

1. Presence and establishment of invasive fish could dramatically alter the CRe and the status of federally listed fish.
2. Prevention is essential to reduce or eliminate further entrainment through GCD and limits future taking of life.
3. Negative impacts from the actions provided in this Plan to LTEMP resources should be avoided, minimized, and/or mitigated.

4. Funding for actions to prevent invasive fish establishment (e.g., GCD modifications and/or an offset for forgoing power generation) should be pursued outside of existing GCDAMP funds where possible.
5. Long-term interagency and intergovernmental coordination among sovereign governments (including federal, state, and tribal) will be necessary to prevent the establishment of invasive fish species below GCD.
6. Actions by DOI will be consistent with tribal trust responsibilities, including any applicable authorities concerning the federal relationship with Tribes (e.g., DOI's Joint Secretarial Order No 3403).
7. Actions should be informed by the Department of the Interior's (DOI's) Invasive Species Strategic Plan and Invasive Species Policy, and should use the best available science to emphasize the use of prevention, early detection, and short-term rapid response.
8. Actions implemented early in the timeline of invasion are less costly and more likely to be successful than actions that are implemented later (see DOI's Phases of the Invasion Curve, Figure 1).
9. A combination of flow and non-flow actions will be necessary to successfully prevent the introduction, spread, and establishment of invasive fish.
10. Actions may be limited by conditions beyond the control of the GCDAMP.

3.0 Strategic Approach

Based on an integrated pest management approach[3], this Plan incorporates the following types of actions:

1) Identify invasive fish species of concern.

2) Prevent the establishment of invasive fish.

3) Monitor the system for new detections of invasive fish.

4) Use existing or establish new guidelines as needed for implementing management actions.

5) Respond to new detections if the action can be effective and limit establishment until a more long-term action can be taken.

6) Monitor the effectiveness of management actions and determine whether additional actions are necessary.

[3] The integrated pest management framework is widely used for invasive species management and is promulgated by the U.S. Environmental Protection Agency and the Office of Pest Management Policy. Please refer to the preamble for more information on cultural considerations.

3.1 Invasive Fishes of Concern

An invasive species is defined by Executive Order 13112 as "non-native (or- alien) to the ecosystem under consideration, and whose introduction causes or is likely to cause economic or environmental harm or harm to human health." Furthermore, species considered invasive in this Plan are only considered invasive within the bounds of the geographical context defined as the CRe (Figure 2). Fishes upstream of GCD and in Lake Powell are outside the scope of this Plan and consequently are not discussed even though they may affect the CRe. For example, Lake Powell is actively managed for recreational fishes including smallmouth bass and striped bass, which are considered invasive in the CRe below Glen Canyon Dam. This Plan focuses on fish species that would be considered invasive if found below GCD. Actions in this Plan are focused on fish passing through GCD and do not necessarily apply to fish movement upstream from Pearce Ferry rapid or down the tributaries. However, select actions, such as short-term rapid response, may need to be modified to address other sources of invasion. This Plan is based on the best available scientific knowledge and understanding of the CRe and is intended to be adaptive to allow modifications as new information becomes available.

The Expanded Non-Native Aquatic Species Management Plan Environmental Assessment was developed by NPS for Glen Canyon National Recreation Area and Grand Canyon National Park and includes actions to address non-native aquatic species. Appendix F-1 of the NPS Plan includes the risk levels of various non-native fish species present and potentially present in the system. The most recent data assessments are available on the NPS Expanded Non-Native Aquatic Species Management Plan Document List webpage. This Plan refers to the Appendix F-1 Risk Levels of Non-Native Aquatic Species table as the foundation when analyzing the threat to native species and the Lees Ferry rainbow trout fishery. The risk levels are assessed annually and subject to change following a peer-review and concurrent technical assessment of new information. Risks from existing and newly detected invasive species will continue to be discussed amongst the cooperating fisheries agencies, consisting of management agencies and science providers, who may provide updates to the risk levels as necessary (see Attachment A, Figure 1). The list of invasive fishes grouped by risk includes consideration of risks when new detections are made. If a new fish is detected, short-term rapid response actions may be implemented by management agencies as described and identified in Attachment A, while other actions may be recommended.

Smallmouth bass have been identified as the invasive fish species of most concern to native fish, particularly humpback chub, and the health of the rainbow trout fishery as of fall 2022. Smallmouth bass have had detrimental effects to chub species in adjacent regions (e.g., the Yampa River; Johnson, 2008), resulting in increased concern for humpback chub in the Grand Canyon. To date, short-term rapid response actions have been implemented to address the existing threat of smallmouth bass below GCD. The October-December 2022 activities (e.g., mechanical removal) to target smallmouth bass below GCD are expanded upon in Attachment B. If invasive species other than smallmouth bass become a concern, actions and strategies presented in this Plan (and attachments) may be modified to best address each new threat.

3.2 Monitoring for Presence of Invasive Fish

Early detection and monitoring is imperative to identify locations of invasive fish species so that actions can be taken to prevent establishment. Regular and recurring monitoring facilitates (1) identifying emerging threats, (2) deploying short-term rapid response management activities during the initial stages of an invasion, (3) tracking relative abundance and distribution of invasive species, and (4) evaluating the success of mitigation measures. Existing fish monitoring protocols target locations in the CRe but have very specific objectives and are not designed to allow time for targeted sampling and/or removal of invasives. A detailed list of river trips conducted in 2022 that are part of the GCDAMP is provided in Attachment C. This list is updated annually as research and management trips vary slightly each year. These recurring trips also provide some monitoring of the presence of invasive fish.

Entrainment through GCD is considered a primary source of potential invasion of invasive fishes, and the Lees Ferry reach is expected to be an initial point of establishment. However, invasive fish may be introduced via several other locations such as the Little Colorado River (and its tributaries), Shinumo Creek, Kanab Creek, Havasu Creek, Bright Angel Creek, and Lake Mead. Monitoring for invasives should include the tributaries listed above. Hot spots where invasive fishes are most likely to be found have been identified by cooperating fisheries agencies from GCD to above Pearce Ferry and are included in Attachment D. This can guide future monitoring efforts. While probable infestation locations should be monitored adequately, mainstem monitoring is also essential to determine distribution of invasive species.

To detect new and invasive fish species in the CRe, it is recommended to (1) expand upon existing monitoring efforts with flexibility to add additional days and survey locations and (2) conduct additional, targeted monitoring trips. These recommendations are further expanded upon in Attachment E to allow for specific recommendations and the ability to update as needed. Proposed modifications to monitoring and research should be coordinated with the GCMRC Triennial Work Plan projects and may include additional work outside of the Work Plan. Additional activities to address invasive fish species in the CRe would require additional and/or separate funding.

3.3 Prevention and Response Actions

The preference for invasive species management is prevention. Prevention actions, such as the fish exclusionary device(s) described below, provide long-term solutions and limit the potential taking of life. To prevent the establishment of invasive fish species in the CRe, a combination of long-term, mid-term, and short-term actions are required. If an invasive species becomes established, eradication will likely not be possible and attempts could come at the cost of other programs or resources in the CRe. On the other hand, “functional eradication” or suppression of a species population is difficult to achieve in a large system such as the CRe (Green, 2020. & Klein, 2022). If invasive fishes become established in the CRe, the costs of extended suppression attempts could come at the expense of other CRe programs and resources. Thus, long-term preventative actions (identified below) should be prioritized, with impacts and trade-offs

considered. While long-term, more permanent action(s) are being prepared and implemented, a combination of mid-term, and short-term actions are required. Prevention and response actions identified in this Plan and attachments should use monitoring data to determine their success. Monitoring for effectiveness is expanded below in Section 3.4.

Long-term management is focused on prevention. The two approaches to prevention within the CRe are (1) the prevention of fish from passing through GCD (entrainment), and (2) the prevention of establishment in the reach(es) below GCD if entrainment occurs. To address the source of invasive fish in Lake Powell, the use of a barrier or modification to GCD could reduce entrainment. If reservoir elevations remain low, entrainment risk will continue to be high, which translates to an increased likelihood of the establishment of invasive fish. Reducing entrainment will address the source of new fishes and be a proactive and preventative approach to invasive fish in the CRe. Therefore it is recommended that Reclamation implement the most effective and feasible option(s) from the Glen Canyon Dam Fish Escapement Options Report as quickly as possible. This long-term action is consistent with LTEMP goals to protect native fish, the rainbow trout fishery, and tribal values protecting life. Fish exclusion devices reduce entrainment but are unlikely to entirely eliminate fish passage through the dam. A combination of a fish exclusionary device(s) and other measures, including actions outside of the GCDAMP (Attachment F), maximize the possibility of long-term prevention of invasive fish establishment. Other actions to address invasive fish below GCD should also be utilized in the interim and may be required after the placement of these long-term actions, dependent upon the efficacy of the preventative methods. Monitoring should be continued to inform adaptive management to address the remaining threat past GCD. If prevention is unattainable and establishment occurs, continuous suppression efforts or maintenance actions may be warranted and considered. This is further expanded upon below under Short-term actions.

Mid-term management actions are those actions that are of limited time and duration, such as targeted flow and temperature changes, that may discourage and disrupt invasive fish from spawning within certain reaches of the Colorado River, specifically from Lees Ferry to the confluence of the Little Colorado River. Priority should be given to the operations that have the highest level of predicted effectiveness, while minimizing trade-offs and impacts to other LTEMP resources, where possible. Effectiveness should factor in the geographical extent of impacts, as well as targeted species. For example, dam operations will likely only affect the mainstem of the river to the Little Colorado River. Other actions will be necessary to protect the tributaries, as well as downstream reaches. When possible, predictive modeling should be used as a tool to compare and contrast the efficacy of different suppression scenarios particularly under various reservoir elevation scenarios that may occur with climate change and aridification.

If more effective alternatives are identified outside of existing compliance that have a higher likelihood of success, additional compliance should be pursued. If impacts are unavoidable, mitigation measures must be identified. For example, if alternatives include the extended use of bypass tubes, it may be possible to mitigate significant impacts to hydropower by adding generation to the bypass tubes, see Attachment F.

The mid-term flow actions described above are not specific to smallmouth bass, but provide the framework for the consideration of potential future actions. The flow options being considered

under Reclamation's current Environmental Assessment for Glen Canyon Dam Operational Flexibilities in Response to Warmwater Invasive Fish are considered a temporary, mid-term action to respond to smallmouth bass. Flow and non-flow actions may still be needed to address invasive fish species remaining below the dam.

Short-term actions will be required while compliance and implementation for long- and mid-term actions are completed. These short-term actions are described more fully in Attachment A. Those details are intended to provide recommended approaches to modify current or initiate new AMP-funded trips, to share new detection information, to recommend new actions, and the incorporation of a science plan.

Additional surveillance may also be necessary, as well as coordination amongst appropriate agencies. Management agencies may respond immediately per their existing planning and compliance but for actions funded by the AMP, the framework would be used as described in Attachment A to recommend further courses of action. A response may be triggered based on the specific detection, as responses may vary based on species, number of individuals, and location. For AMP-funded actions, this Plan recommends that a risk assessment, management actions, and offramps will be discussed. An example short-term rapid response is provided through the smallmouth bass science plan for the fall of 2022 that provides a framework for the assessment and evaluation of actions (Attachment B). Additional actions that have compliance for non-native aquatic invasive species removals can also be found in the National Park Service's Expanded Non-Native Aquatic Species Management Plan and are detailed in Attachment C. Inclusion of actions described in National Park Service's 2019 Expanded Non-Native Aquatic Species Management Plan does not indicate that resources are available to implement these actions.

Short-term rapid response actions may be successful in the short-term to prevent widespread dispersal and establishment but differ from long-term responses that may require continuous suppression (Breton et al., 2014). However, the costly and relatively less effective nature of continuous suppression efforts and potential impacts to other resources, underscores the need to implement the proposed mid-and long-term actions as soon as possible. Cooperating fisheries agencies should be prepared to continue, amend or stop short-term rapid response actions based on the likelihood of success, cost-effectiveness, and changing environmental conditions. Although results will vary, preventative measures are often cheaper and more effective than mitigation once an invasive species is established (Lovell et al 2006; Simberloff et al 2013). Ongoing interagency coordination and evaluation will be necessary to provide adequate information and decision making for invasive species management in the CRe.

Educational outreach is a necessary component to invasive species management. By identifying invasive fish, citizen scientists and anglers can help expand early detection efforts and supplement observational data collected by management agencies. Educating the public and encouraging anglers to report and remove invasive fish species when caught assists with management actions to prevent establishment of invasive species. Educational outreach may include materials provided with permits, personnel on the ground talking to the public (interpretation guides, creel surveys), informational signs, press releases, and/or social media campaigns. Some educational actions could be short-term, while some will be needed long-term

to ensure continued education of new recreationalists. Additional outreach considerations are discussed in Attachment A (short-term rapid response focused) and Attachment F (long-term program considerations).

3.4 Monitoring the Effectiveness of Actions

Existing monitoring is outlined in the 2021-2023 Triennial Work Plan and discussed in Section 3.2. Monitoring trips should be designed to include an assessment of the effectiveness of all actions (prevention and response). Actions should be implemented experimentally to allow proper evaluation. Continued evaluation is recommended for all actions described in this plan, including the fish exclusionary device(s), operational alternatives, and short-term rapid response actions.

Implementation and continuation. Focused monitoring and research efforts should be adapted if a new detection of an invasive species is made that requires further information to facilitate management decisions. Monitoring and increased surveillance will also provide information to consider if a response is indicated, such as the number of fish and the river mile at which those fish were detected. The cooperating fisheries agencies will regularly meet to assess and determine if a response is needed for potential short-term rapid response actions, and will provide recommendations on the implementation, continuation, and offramping of actions as outlined in Attachment A. Response criteria and actions allowed under current compliance are described in the NPS Expanded Non-native EA (2019), and summarized in Attachment C. If the action is not covered under existing compliance, the recommended action may then require stakeholder input and additional processes prior to implementation. Some actions, such as the fish exclusionary device(s) and operational alternatives may require a different process for considering next steps which is currently outside the scope of this Plan.

Offramps (e.g., potential discontinuation) of any short-, mid-, and long-term action should be considered if the specified action(s) are successful and no longer needed, are no longer effective, or if the action(s) are deemed cost prohibitive after a certain length of time. Offramps should consider, but are not limited to: (1) the distribution of an invasive fish (by river miles), (2) population numbers and evidence of spawning, (3) effectiveness of the action(s), (4) the associated costs if such action(s) were continued, (5) consideration of the time and resources that have been dedicated to existing actions, (6) shifting to more appropriate actions if deemed necessary, and (7) the current stage and location in the DOI's Phases of the Invasion Curve (Figure 1). Regular reporting is one means by which managers could assess the situation for triggering the discontinuation of actions. A proposed framework to facilitate this process for short-term rapid response actions is further defined in Attachment A, Figure 1. Potential triggers for discontinuing actions specific to mid- and long-term actions have yet to be identified and would require additional considerations and processes which would include GCDAMP stakeholders and appropriate agencies.

4.0 Concluding Statement and Implementation Recommendation

This Plan incorporates management strategies included in NPS and AZGFD plans and identifies additional elements that, in combination, could achieve the Secretary's Designee's Directive and protect the resources described in the LTEMP BO. This Plan is intended to be a living document and should be periodically re-evaluated and/or updated by the GCDAMP, to account for ongoing changes in the CRe.

During the development of this Plan, smallmouth bass young-of-year were discovered in Lees Ferry (initial discovery on June 30, 2022). The seasonal timing, size and location of the smallmouth bass suggest spawning may have occurred in Lees Ferry. Further otolith analysis will be necessary to confirm this (Attachment B). Smallmouth bass spawning typically begins in June but could potentially begin earlier or later depending on lake elevations and release temperatures, as the timing of spawning is directly correlated with temperature (Cantin, 1994). Research in the Upper Colorado River Basin showed spawning was triggered at approximately 16°C (Breton et al. 2015). Temperatures in Lees Ferry reached 16°C in early June of 2022, indicating the need for implementation of actions designed to disrupt spawning to be implemented by late spring/early summer of 2023. In the Upper Basin, long-term mechanical removal efforts targeting smallmouth are costly and are only effective when uncontrolled, environmental conditions are unfavorable to smallmouth (Breton et al 2014). Previous research has estimated that long-term reductions in smallmouth populations require nearly 70% removal of young of year for at least ten consecutive years (Loppnow & Venturelli, 2014). This type of intensive, long-term smallmouth bass management, or "functional eradication" as described in Section 3.3, is likely not physically possible in the CRe, and associated economic costs to attempt such an eradication could be orders of magnitude greater than prevention or early eradication.

While actions to meet the direction of the Secretary's Designee have potential trade-offs and may need additional compliance and consultation with Tribes before they can be implemented, it is imperative that (1) future fish entrainment is limited to the greatest extent possible (long-term prevention), (2) dam operations create an inhospitable environment for invasive fish already below GCD (mid-term prevention), and (3) short-term rapid response actions be conducted to address ongoing expansions of existing non-native species and newly detected individuals. These actions must be implemented in a cohesive way to succeed in preventing the establishment of smallmouth bass and other invasive fish. Additional compliance and experimental implementation will be required for actions in this Plan that are not covered by LTEMP or NPS compliance. A compliance process has been initiated by Reclamation to implement operational alternatives by a target date of March 2023 for smallmouth bass (Bucklin et al., 2022). While potential management actions are presented in this document, many resource gaps (e.g., personnel, equipment, funding) have been identified as barriers to successfully implement these actions. Additional funding, other than power revenues, and beyond that provided by GCDAMP and the Native Fish Conservation Contingency Fund, are necessary to implement the actions outlined in this Plan. The actions presented in this plan do not supersede the need to acquire compliance with federal laws and conduct intergovernmental consultation with Tribes.

Beneficial use of removed invasive fish is recommended when possible, as are approaches to limit the taking of life. This document is focused on the technical strategies available for consideration in response to invasive fish species. In order for the strategies included in this Plan to be successful, an agency or agencies will need to serve as the lead for specific actions in this Plan. Defining roles in an agreement should be accomplished as soon as possible.

Members of the GCDAMP have provided various options and support for the prevention of invasive fish establishment below GCD in an effort to uphold the program's mission as provided by the Grand Canyon Protection Act of 1992. Reservoir storage decisions, as well as system conservation efforts, that are outside the scope of this Plan and the GCDAMP could provide a long-term solution by decreasing entrainment risks from Lake Powell through increasing reservoir elevation (Bruckerhoff et al., 2022 & Dibble et al., 2021; Attachment F). During this time of unprecedented drought and hydrologic conditions on the Colorado River, we encourage a swift and adaptive approach to address and manage for the long-term prevention of invasive fish in the CRe.

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Figures

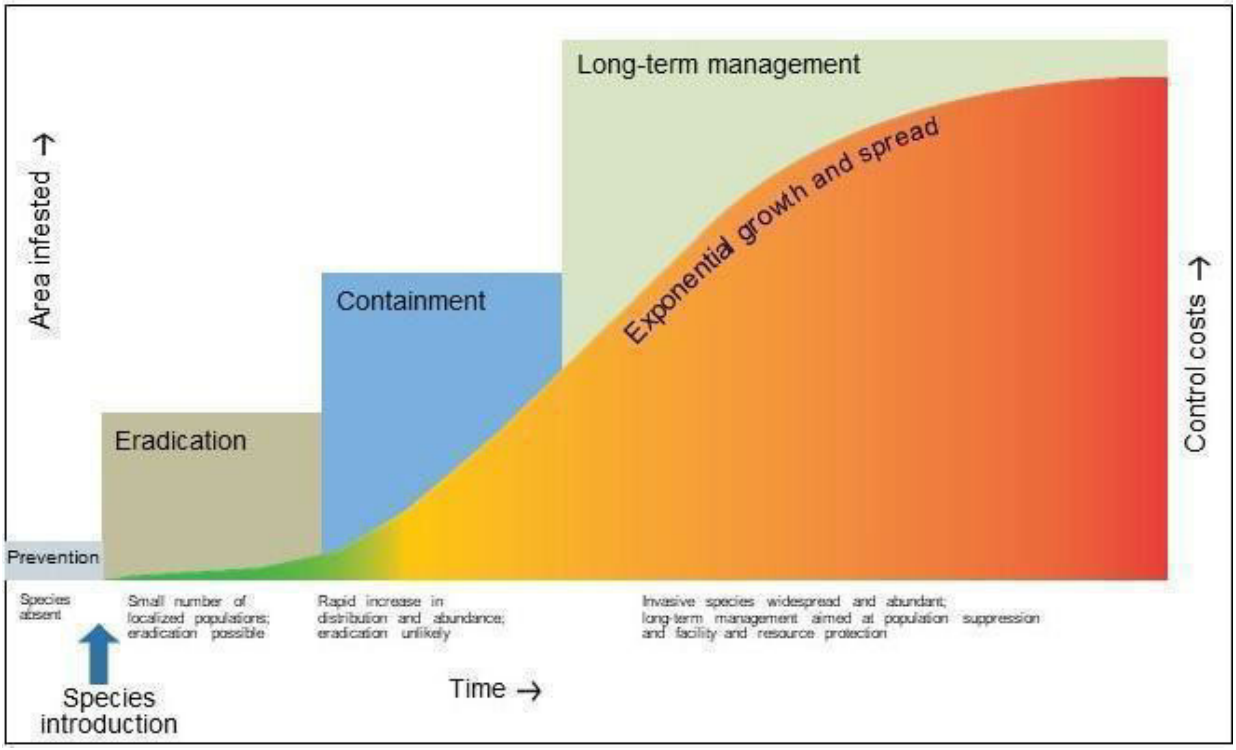

Figure 1. Phases of the Invasion Curve. United States Department of the Interior, Invasive Species Strategic Plan 2021-2025 (Adapted from Rodgers. 2010. Invasive Plants and Animals Policy Framework. State of Victoria, Department of Primary Industries).

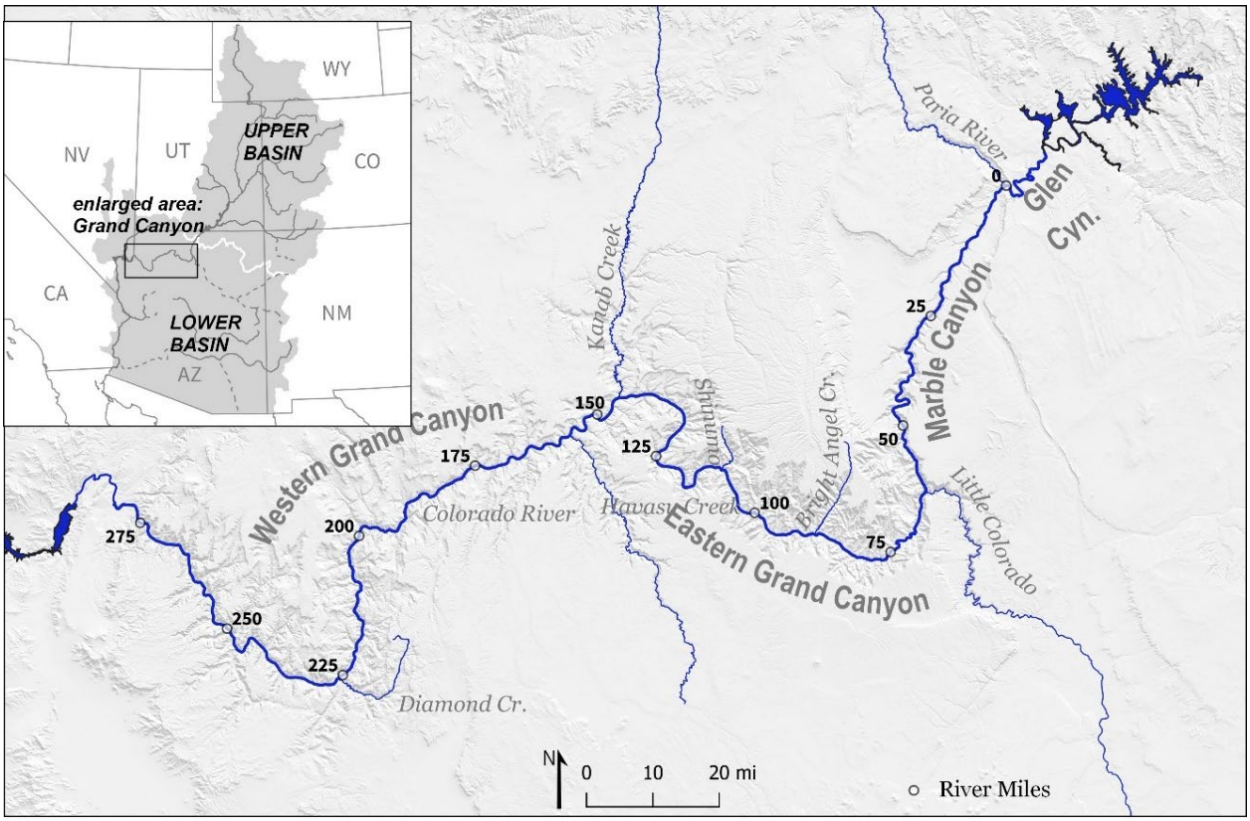

Figure 2. Geographical extent of the CRe. Provided by David Rogowski, AZGFD.

Appendix:

Attachment A: Short-Term Rapid Response

Attachment B: GCMRC Science Plan - SMB

Attachment C: Existing Actions & Monitoring

Attachment D: Hot Spot Table

Attachment E: Additional Monitoring

Attachment F: Supplemental Actions

Attachment G: Implementation Considerations

Attachment H: Tribal Positions

Short-Term Rapid Response Framework to Prevent Invasive Fish Species Establishment Below Glen Canyon Dam

This document provides a preliminary framework for potential future short-term rapid response protocol and actions to respond to invasive fishes below Glen Canyon Dam (GCD). Rapid response is defined as "a process that is employed to eradicate the founding population of a non-native species from a specific location before it becomes established or spreads so widely that eradication is no longer feasible" (DOI Department Manual 524 DM 1). Rapid response is further explained by DOI in the National Framework for Early Detection and Rapid Response, explaining the goal and focus of rapid response is the eradication of the targeted species. Thus, specific rapid response actions mentioned below focus on eradication. However, eradication is not always feasible and other management strategies may be implemented. This is intended to be a technical document focused on the rapid assessment[1] and following rapid response actions, such as mechanical removal and chemical treatments. These actions will be coordinated and conducted by the cooperating fisheries agencies (identified below), which consist of both management and science provider agencies. Integration and notification to Glen Canyon Dam Adaptive Management Program (GCDAMP) stakeholders will include notification of new detections and potential actions to the GCDAMP Technical Work Group (TWG) Chair, who will provide updates through the Steering Committee Ad Hoc Group. This plan is not intended to curtail or restrict management agency actions already available under existing planning and compliance. A comprehensive summary of actions for which compliance has been obtained through existing management plans can be found in Attachment C: *Existing Actions and Monitoring.*

Outreach and Reporting Protocol

The purpose of this protocol is to inform the public, recreationalists, river guides, and biologists regarding invasive fish species of interest below GCD, and how to report detections of them to appropriate authorities. A designated coordinator of the short-term rapid response and detection efforts could develop and maintain past and present invasive fish detections. For example, an online database could be developed and regularly updated to represent the status of invasive fish detections. This database could include the reported capture and/or detection details and an associated map. This information could be posted on an NPS webpage or the GCDAMP Wiki webpage.

[1] *Rapid assessment:* Determines the distribution and abundance of the species occurrence, if possible, and evaluates its potential risks with regard to environmental, health, and economic impacts. It also identifies options for rapid response based on the particular circumstances associated with the occurrence of the species (e.g., species type, specific location, extent of spread, relevant jurisdictions/ authorities) (DOI 2016).

Outreach:

- Post informative flyers to relevant public information boards at boat launches below GCD.
- Post and share information regarding invasive species of concern on websites hosted by NPS, AZGFD, USFWS, and other stakeholders.
- Provide informational flyers to recreators when obtaining permits.
- Utilize media to share information as appropriate.
- Develop a 24/7 call-in report number, email address, and/or NPS-hosted form on the Non-Native Aquatic Species EA webpage for anyone to report detections of invasive fishes of concern.
    - Detailed instructions on how and what to report should be widely distributed and shared via the outreach mechanisms described above.

Detection and Reporting of Invasive Fish Sightings:

Details needed for detection reporting may include:

- Species identified
- Location of detection (i.e., RM, local place name, side of river, GPS coordinates)
- Number and size of fish
- Behavior and other pertinent details (e.g., sitting on a nest, under a rock wall, etc.)
- Time and date of observation
- Assessment of certainty in species identification and count
- Picture for visual confirmation, if possible

Addressing New Detections and Identifying Next Steps:

Once cooperating fisheries agencies are made aware of a detection, they evaluate the credibility of the detection, assess the situation, and recommend a response (if needed) per their existing planning and compliance. An assessment and response process is outlined in Figure 1 which may be used by agencies upon detecting new species or locations. Detection reports should be received centrally (e.g., via call-in number, email address, or web form) and distributed to a contact list composed of the following management and science agencies, defined as the "cooperating fisheries agencies" throughout the plan: National Park Service, Arizona Game and Fish Department, US Geological Survey, US Fish and Wildlife Service, and the US Bureau of Reclamation. This contact list should prioritize and identify key contacts who can assess reported information and coordinate a response. A coordinator for this action needs to be identified to ensure timeliness and effectiveness of the emergency notification process.

If deemed necessary, subsequent actions required to facilitate a short-term rapid response will depend on the available resources at the time (i.e., staffing, equipment, funding), and remain at the discretion of the cooperating management agencies.

Short-term Rapid Response Options:

For GCDAMP funded activities, the initiation, evaluation and offramping process of rapid response actions has been developed by the GCDAMP cooperating fisheries agencies and is outlined in Figure 1. The cooperating fisheries agencies should come to a consensus, if possible, then provide the recommended actions to the GCDAMP stakeholders in the processes identified above. The recommendation process and suggested actions will be dependent upon whether the source of funding is provided through the program. All proposed actions will require flexible use of available staffing and equipment from the cooperating fisheries agencies. Until additional resources are identified, personnel costs will need to be covered from within each responding agency and staff/equipment availability may be limited. Additional compliance, consultation, and/or permitting may be required for specific actions outside of existing management plans (see Attachment C: *Existing Actions and Monitoring*). These responsibilities will fall to the lead agency who will have ownership of the actions. A brief summary of the proposed short-term rapid response options to date are listed below.

1) New river trip(s) should be developed to address the detection of the invasive species of concern. For example, in the fall of 2022, management agencies, in coordination with the Grand Canyon Monitoring and Research Center (GCMRC), developed a 6-week rapid response protocol and science plan to address smallmouth bass (SMB) below GCD (Attachment B).

2) Modifying and/or repurposing existing monitoring trip(s) should be considered. For example, it may be possible to add 1-2 biologists (and necessary equipment) to an existing trip which has the capacity to add a stopover at the reported site. In September 2022 the USFWS was able to repurpose an existing Western Grand Canyon monitoring trip to address new detections of SMB by conducting backwater seining for young of year fish from Lees Ferry to Diamond Creek.

3) Develop a citizen scientist program through a partnership between the commercial guided trips and fisheries biologists. Identify potential opportunities for biologists from coordinating management agencies to join existing commercial trip(s) to respond to the detected invasive species of concern. Coordination of equipment and personnel as well as agreement from the guide company will be required. This could allow those on commercial trips to learn about the biology of the CRe and have an additional memorable experience. This could be offered on select trips for those interested in the experience and/or volunteering. Special permitting may be required and further detailed planning necessary.

4) Maximize participation from the angler community. Alert anglers via flyers, word of mouth, webpages, and bulletins of the new invasive fish detection(s) and request assistance. Management agencies may be able to provide gear and equipment for select anglers/guides who will volunteer to fish for, and report on the

targeted invasive species, if observed while on the water. This may require regulation exemption through a permit or other authorization for specific anglers and actions. If funding is available, consider hiring and/or funding one or more local guide(s) (such as a skilled bass angler) to actively fish for and remove targeted invasive fish during vulnerable periods (spawning season). If determined to be feasible and appropriate, this task will require further development and agreements.

5) While the actions provided in this document are described as short-term, the techniques used in these actions could be adapted and utilized in mid- to long-term efforts to suppress an established population. Should a change from rapid response actions intended to suppress high risk non-native species be needed, additional analysis and assessment of cost, impacts to resources, and other policy considerations should be conducted. Additionally, a shift to suppression efforts would no longer be considered short-term, and further management of an established species should be informed by the stage of the invasion curve, and other external factors, such as the ability to implement the preventative mid- and long-term actions described in the Plan. This does not prohibit an agency from conducting reoccurring rapid response actions within their existing plans and compliance in response to new threats or changes in the status of existing species, but acknowledges that the Plan currently does not address long-term management of an established population.

Implementation Challenges and Considerations:

Although a short-term rapid response action must happen quickly to be most effective, it may be difficult for agencies within the GCDAMP to mobilize given staff and resource constraints. Management agencies working through a third-party contractor (i.e., supplemental experienced boat operators) may be better suited to mobilize within the recommended time frame and increase likelihood of success. This could allow for more extensive response actions without affecting existing and future GCDAMP project trips and resources. However, permits to cover actions conducted by a third-party contractor may introduce additional hurdles, and may require interagency discussions amongst management authorities. When possible, it is recommended to use existing management agencies and science providers who may be best positioned to integrate data and new information. A designated funded coordinator position may also be necessary to quickly and functionally utilize the rapid response contact list and organize logistics. Depending on the development of the actions outlined here, and the level of support for such actions, this could be a full-time position supported through one of the cooperating fisheries agencies or added to the role of a current position.

Rapid Response Assessment:

Below is the general process and consideration of AMP Funded actions. This does not supersede any agency's given authority and responsibilities, as the process presented may also be altered depending on who has ownership of this Plan and how it is implemented. This was provided to meet a component of the Secretary's Designee's Directive to determine triggers and offramps, as those contain much complexity, a general framework to assess and consider actions is provided.

Ideally, a small group with the technical expertise to properly assess potential actions must weigh each situation/circumstance and make the determination – documenting how they determined 1) risk level, 2) action feasibility, and 3) action effectiveness. Refer to Figure 1 and Table 1 below for decision making guides.

Risk framework:

Given an invasive fish detection and subsequent monitoring and using information including species, known or likely abundance, life stage, behavior, location, and timing, agencies will make a determination of the associated risk. The cooperating fisheries agencies will discuss and evaluate the risk presented to the Grand Canyon ecosystem, including federally listed species, using consequence severity and consequence likelihood as a guiding framework (Table 1). A determination of no significant risk results in continued monitoring or offramping, and a determination of significant risk continues rapid response consideration.

Feasibility framework:

Estimate the probability of capture of the invasive species with a given gear type(s). Probability of capture is based on published literature and previous observations/testing. For example, based on an estimated probability of capture, consideration of actions should include if eradication is likely feasible given the information provided by initial detection and follow-up monitoring.

It is important to note that a management action may be feasible, but may not be the right decision for implementation due to cost, impacts to resources, and/or other policy driven decisions. This flow chart does not account for that potential split.

Effectiveness framework:

To determine effectiveness of actions, the probability of capture determined during feasibility assessment will be used. If the catch rates equal or exceed the estimated probability of capture associated with eradication, then the action may be considered effective. If not, the action was likely not effective, and reevaluation of actions ensues. This can result in a new rapid response strategy or long-term management actions and continued monitoring.

[Note: the most effective way to estimate population size and capture rates is to do a first pass of mark/release with subsequent removal passes. However, releasing invasive species will likely be contentious.]

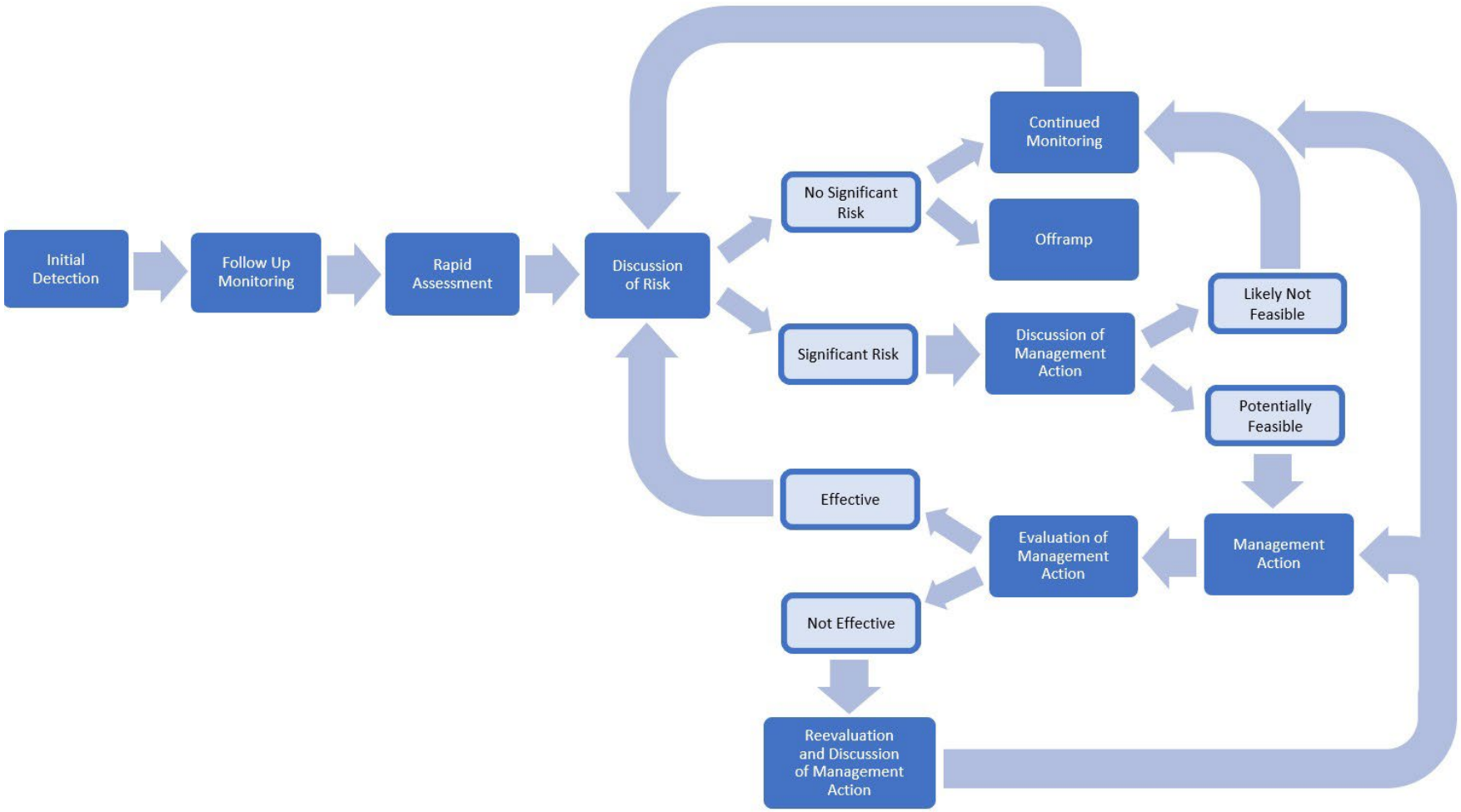

Figure 1. Flow chart describing the Rapid Response Assessment and Response Process. Developed by Drew Eppehimer, GCMRC with input from USFWS, NPS, & AZGFD.

Table 1: Rapid response risk framework developed by Kirk Young, (former USFWS employee) with input from GCMRC & AGFD

	Severity			
Likelihood	Negligible	Marginal	Critical	Catastrophic
Frequent				
Probable				
Occasional				
Remote				
Improbable				

Severity Definitions	
Catastrophic	Loss of the system
Critical	Major system damage
Marginal	Minor system damage
Negligible	Less than minor system damage

Likelihood Definitions	
Frequent	Likely to occur often
Probable	Will occur several times
Occasional	Likely to occur sometime
Remote	Unlikely to occur, but possible
Improbable	Very unlikely, assumed it will not occur

Science Plan to Support Management of Smallmouth Bass in the Glen Canyon Reach of the Colorado River, Lees Ferry to Glen Canyon Dam

Background:

Smallmouth bass (*Micropterus dolomieu*, hereafter SMB) are a high-risk, nonnative species within the Colorado River Basin that is established in Lake Powell. SMB are a highly valued sport fish that have been introduced throughout the globe and have often spread extensively beyond their initial point of introduction (Loppnow *et al*., 2013). SMB invasion into rivers throughout the globe have been associated with substantial population declines, and in many instances, extirpations of native fish species (Brown *et al.,* 2009; Loppnow *et al*., 2013). In the upper Colorado River basin, SMB are considered the greatest threat to the persistence of threatened and endangered fish species (Johnson *et al.* 2008). SMB are fecund, adaptable to a substantial range of environmental conditions, and extremely capable predators able to consume many size classes of the federally listed humpback chub (*Gila Cypha*) (Edwards *et al.,* 1983; Johnson *et al.,* 2008; Ward & Vaage, 2019). These traits have allowed SMB to quickly increase in abundance and exert negative population level impacts to species that did not co-evolve with them.

SMB have rarely been observed in the Colorado River ecosystem below Glen Canyon Dam (hereafter the CRe) during the last two decades (USGS, unpublished data), however, reproduction was identified for the first time in 2022 (NPS, unpublished data). Historically low reservoir elevations in Lake Powell have contributed to dramatic warming of water release temperatures making the river more suitable for SMB reproduction, while lowered reservoir elevations have likely led to more entrainment of adult SMB that occupy the shallower parts of the water column in Lake Powell. The first reported CRe SMB capture was in 2003, and through 2021, a total of twenty-two SMB were captured with no more than five individuals caught per year (USGS, unpublished data). More than 50% of these SMB were captured in the Glen Canyon reach of the CRe (Fig. 1: the reach from Glen Canyon Dam to the confluence of the Colorado River and the Paria River) indicating likely passage of fish through Glen Canyon Dam. Historically cool river temperatures, particularly in Lees Ferry, have likely mitigated SMB reproduction and population establishment. Previous work in North America has identified 15°C as a threshold for SMB spawning initiation (Shuter *et al*., 1980; Lawrence *et al*., 2015). In the Upper Basin, this thermal threshold has been estimated to be 16°C (Breton *et al.,* 2015; Bestgen & Hill, 2016). While temperatures have exceeded 16°C for brief periods in the Lees Ferry reach during September and October of a few years (e.g., 2005, 2021) in the last half of a century, they had never reached these thresholds in earlier months and had not exceeded 17°C in over 50 years (Voichick & Wright, 2007; USGS gage 09380000). In 2022, river temperatures exceeded 16°C by June 8th and have hovered around 19-21°C for multiple months.

In 2022, >45 SMB have been captured in Lees Ferry including 30 young of year individuals captured in the mainstem river during regular monitoring in September by USGS (USGS & NPS, unpublished data). Twenty-seven of these fish were captured during two electrofishing passes in a river segment located nearer to the dam (segment B in Fig. 1), while three were captured during two electrofishing passes in a river segment located further downriver (segment F). All 30 SMB were removed from the river and preserved in accordance with permitting requirement and for the purpose of future analysis of otoliths to identify hatch dates. Following these findings, multiple Federal and State agencies have requested additional research to identify whether electrofishing sampling targeted at SMB has potential as a management tool to significantly lower the abundance of young of year and/or adult SMB. Here we describe a study plan to be implemented jointly by USGS, National Park Service (NPS), US Fish and Wildlife Service (FWS), Bureau of Reclamation (Reclamation), and Arizona Game and Fish Department (AZGFD) to address questions raised by management agencies.

Hypotheses:

Hypothesis 1 – Mechanical removal via electrofishing can cause a significant depletion in catch of young of year SMB.

Hypothesis 2 – At present, SMB young of year are primarily distributed in the upper portions of the Glen Canyon reach. This hypothesis is based on the distribution of catch from the two sites used in GCMRC's Trout Reproductive and Growth Dynamics (TRGD) study, anecdotal reports of adult SMB near the Dam (RM -15.6; where Lees Ferry is designated as RM0) and detection of juvenile SMB in a side habitat located near -12 RM that is often referred to as the "slough" since early July 2022. This hypothesis assumes that a nest, or nests, were located either near the dam or in the slough and there has been limited dispersal over the last few months.

Hypothesis 3 – Young of year SMB present in the system in 2022 were hatched from one or a few nests with a hatch date in June.

Hypothesis 4 – Electrofishing will be less cost-effective for removing adult SMB than other gears.

Study Plan:

Objective. To address Hypotheses 1-4 and inform both current management (i.e., the National Park Service has compliance and a desire to remove SMB) and future management (e.g., the Bureau of Reclamation is currently considering changes to operations to prevent SMB reproduction and seeking compliance that could be informed by addressing Hypothesis 3), we suggest the following phased approach to study. Hypothesis 3 will require additional analysis of otoliths from young of year SMB captured during all sampling efforts. Hypothesis 4 will be addressed by comparing capture of adult SMB captured during electrofishing to captures of adult SMB via other methods (e.g., angling, trammel netting), which will be undertaken concurrent with the phased approach described below specifically to address hypothesis 4.

Elements common to all Phases. Research will adopt some features of the TRGD project described in the FY2021-23 Triennial workplan of the Glen Canyon Dam Adaptive Management Program but will modify methods to maximize the efficiency of SMB depletions and minimize impacts to salmonids.

Important features of this project to be include: 1) electrofishing of pre-defined 250-m sections established throughout Glen Canyon and used by USGS and its cooperators to facilitate comparisons among different sampling programs and to ensure that the location of all specimens can be identified to this resolution, 2) a relatively slow rate of shocking (i.e., roughly 15 minutes per 250-m section) which increases capture of smaller bodied fish, and 3) sampling of adjoining river sections on both sides of the river to iteratively sample a larger area (typically 3 km in length) over the course of one night of sampling (referred to as a pass). In contrast to TRGD, this study will focus on collecting smallmouth bass and minimizing handling of, and impacts to, salmonids. During electrofishing, all fish within the electrical field will be removed from the river to minimize exposure to the electrical field and placed in buckets equipped with both an aerator and oxygen stone. After a section has been sampled, technicians will sort through the buckets, returning nontarget species including salmonids, carp, and flannelmouth sucker as quickly as possible to the center of the segment from which they were taken. Counts by species of fish released alive will be kept and any incidental mortalities will be retained and counted.

Data collection. The fork length (to nearest mm) of each SMB will be measured, attributed to the appropriate 250-m segment, and preserved in ethanol for future analyses focused on Hypothesis 3.

A) **Phase 1.** Initial efforts will focus on testing Hypothesis 1. To operationalize Hypothesis 1, we begin by defining a metric based on the formula for estimating capture probability from two passes of depletion under the assumption of a constant capture probability. The criteria for judging effectiveness of depletions is the difference in catch between two successive passes divided by the catch in the first of the two passes (i.e., $\frac{Ci-Ci+1}{Ci}$ where C_i is the catch in the ith pass and C_{i+1} is the catch in the following pass). If this metric (capture probability) is 0.1 or greater for the majority of passes it will be taken as evidence of a significant depletion effect.

B) Sampling will begin with one pass of electrofishing in river segment A on both sides of the river (Fig. 1). If fewer than five young of year SMB are caught in the first pass of river segment A, the next night's efforts will occur in river segment C. If fewer than five SMB are caught in the first pass of river segment C, the next night's effort will occur in river segment D. If fewer than five SMB are caught in the first pass of river segment D, the next night's effort will occur in river segment E. If fewer than five SMB are caught in the first pass of river segment E, the next night's effort will occur in river segment B. If fewer than five SMB are caught in the first pass of river segment B, it will be assumed that Hypothesis 1 has been rejected under current conditions (e.g., current temperature and size of young of year are two factors that may lead to declining capture probabilities over the course of a season) and the study will be halted. Note that segment B is being delayed during Phase 1 because 27 SMB were removed from this segment during the TRGD trip in September and

neighboring reaches may provide better conditions for testing hypothesis 1. Segments F – H will not be sampled during Phase 1 as we expect abundances are lower in these segments and higher abundances will lead to a better test of hypothesis 1. All Segments will be sampled during Phase 2 and 3 if these Phases occur.

C) If five or more SMB are caught within a river segment, additional passes will be undertaken in the same river segment until fewer than five smallmouth bass are caught in a pass or a total of five passes has occurred. If analysis of data from these successive passes indicates evidence of significant depletion in catch (defined in part A above), it will trigger Phase 2 of the study. If there is insufficient evidence of a depletion effect, efforts will shift to the next river segment (according to part B above) and undertake a second set of depletion passes (provided five or more SMB are caught) and analyze data from this second set of passes. If this second set of passes shows evidence of depletions the study will move to Phase 2. If it does not the study will be halted.

Phase 2. Efforts will focus on determining the distribution of SMB (Hypothesis 2).

A) Sampling will continue in river segments not sampled during Phase 1 applying the same criteria to determine whether additional passes are warranted (i.e., stopping when a pass produces less than five SMB).

B) After all river segments (A – H) have been sampled, representatives from cooperating agencies will meet to assess potential negative impacts to the rainbow trout fishery, the availability of additional resources, and results from phases 1 and 2 to determine whether the study should proceed to Phase 3.

Phase 3. Additional examination of Hypotheses 1 and 2.

A) Sampling will focus on river segments from which the largest numbers of individuals have already been removed. If there is clear evidence of smaller scale hotspots sampling will focus on these areas. Similar offramps to those outlined in Phase 1 (i.e., total catch scaled by site length of approximately 5 SMB per 3 km and continued effectiveness of depletions) will apply.

Supplemental Work:

Hypothesis 3: Otoliths will be collected from all SMB during all phases. These will be analyzed in the future to address Hypothesis 3.

Hypothesis 4: This hypothesis will be tested by comparing catch data of adult SMB from electrofishing efforts described above and that of additional capture methods that have been, or will be, employed (e.g., trammel netting, fyke netting, hoop netting, angling) by cooperating agencies. Comparison of these data will be conducted by scientists from the cooperating agencies at the annual fish cooperators meeting in December 2022.

Products:

The results of this study will be distributed as an USGS Open File Report or similar peer reviewed outlet and will be coproduced by cooperating agencies including USGS, NPS, USFWS, Bureau of Reclamation, and AZGFD.

Figures:

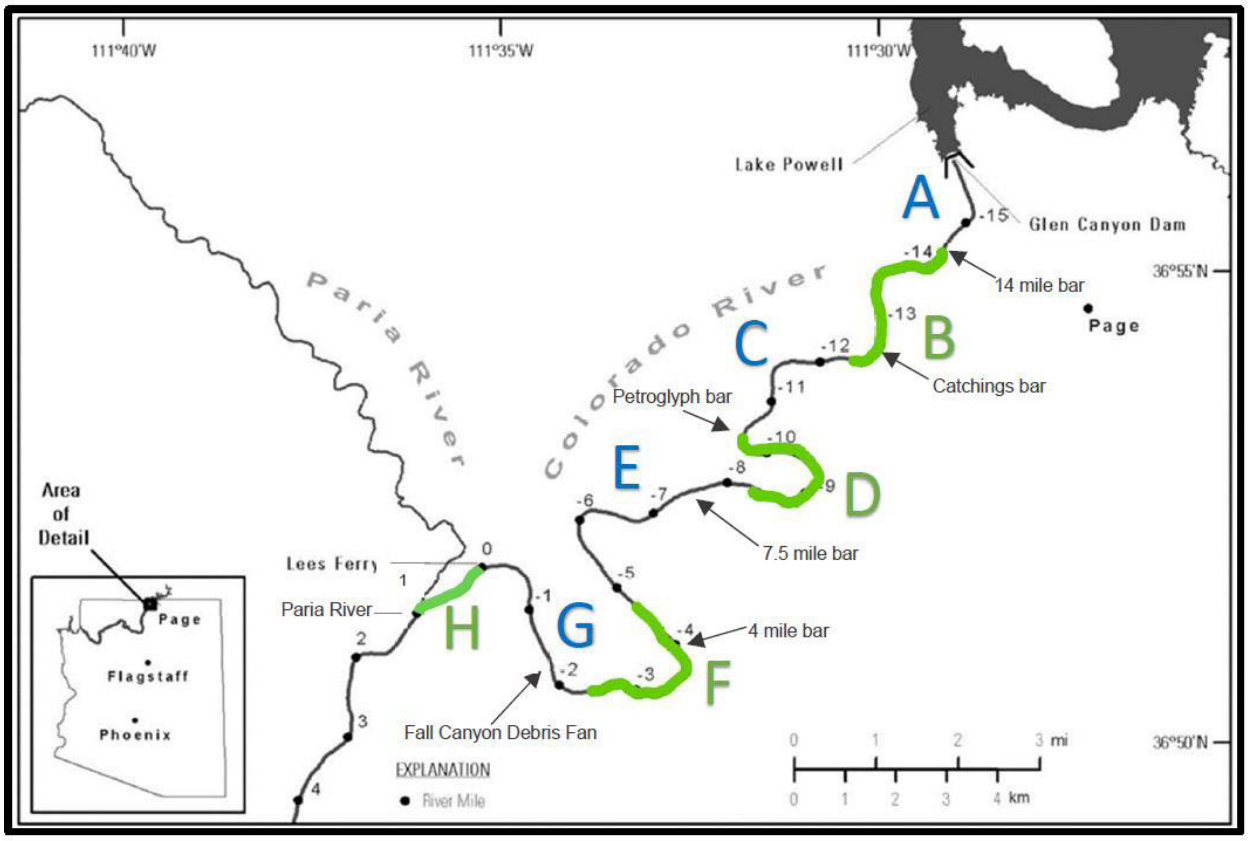

Figure 1. Colorado River sampling segments from Glen Canyon Dam downstream to the Paria River confluence to monitor for smallmouth bass (Micropterus dolomieu) distribution and relative abundance and test the effectiveness of depletions via multi-pass electrofishing surveys.

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Table 1: Fisheries Actions within Current Compliance

ACTION (*grouped by common themes*)	Brief summary *(including any required consultation & coordination)*	Target Species	Target Habitat	Location	Tier level *(NPS documents only, based on tribal consultation)*	Lead management agency	Compliance document
Mechanical							
Emergency Response to New/expanded Introduction	Allows for temporary, short-term, targeted removal effort to treat known occurrences of the new threat using mechanical methods including angling, electro-fishing, and passive (e.g. .. trap nets) or active (e.g., seining) netting. Discovery of an expansion in distribution or abundance of an existing high risk non-native species or the new detection of a rapidly spreading AIS or non-native fish species.	New non-native species	all	entire project area	1	NPS	CFMP
Mechanical Removal: Species Selective	This is mechanical removal of an on-going nature in the sloughs. Any rapid response mechanical removal is allowed here also under the CFMP rapid response mech action.	Any harmful NNAS	RM -12	Both Sloughs	1	NPS	Expanded NNASMP
Harvesting/Angling							
Incentive Harvest (Not Brown Trout or RM -12 sloughs)	tier I - this could be used for species other than brown trout but we would evaluate risks before opening for other species. This may not be useful for rare non-natives for a number of reasons.	NNAS, (Not BNT)	All, not sloughs	Glen Canyon NRA (not RM-12 Sloughs or BRT)	1	NPS	Expanded NNASMP
Coordinate Trips to Harvest Catfish and other Warm-water Species using Angler Volunteers from Below Diamond Creek to LAKE	For Alternative 1 and 2, not done. Alternative 3 shows "Catfish angling opportunity coordinated with Hualapai Tribe below Diamond Creek"	Catfish and other Warm- water non-native fish	Lower Colorado River FMZ	Grand Canyon National Park	1	NPS	CFMP
Brown Trout Incentivized Harvest	tier I - encouraging human consumption by the public - NPS committed to trying this action for 3 years	Brown Trout	All	Glen Canyon Reach	1	NPS	Expanded NNASMP
Targeted Volunteer Angling-facilitated River Trips with Mandatory Harvest of Rainbow Trout	Non-commercial Trips in Marble Canyon and Downstream (Paria Riffle to RM 60)	Rainbow Trout	Marble Canyon FMZ	Grand Canyon National Park	1	NPS	CFMP
Anglers encouraged to remove Brown Trout when caught	Anglers will be encouraged to remove Brown Trout when they are caught.	Brown Trout	All Lees Ferry Fisheries region (?)	All Lees Ferry Fisheries region (?)	N/A	AZGFD	Lees Ferry Fisheries ma
Electrofishing, Angling, Netting							
Mainstream/Inflow Non-native Fish Control (Boat Electrofishing/angling) for Striped Bass, Catfish	Only as Needed per Established Criteria	Striped Bass, Catfish	Havasu Creek and Inflow FMZ	Grand Canyon National Park	1	NPS	CFMP
Non-native Control Mechanical (netting, angling, electro-fishing)	Only if Emergency Response is Triggered or Pending Further Section 106, NEPA, and ESA Planning and Compliance		Other Tributaries	Grand Canyon National Park	1	NPS	CFMP
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)	This is mechanical removal of an on-going/larger scale that occurs in Grand Canyon. This was setup as a tier 1 action under the CFMP. Any rapid response mechanical removal targeting SMB or other high priority new fish that hasn't occurred for 3 consecutive years or 5 total does not fall under this action but is allowed in this location under the CFMP rapid response mech action.	Any Harmful Non-native Aquatic Species	Small localized spawning and congregation areas	Grand Canyon National Park: Colorado River Mainstem and Tributaries	1	NPS	Expanded NNASMP

Table 1: Fisheries Actions within Current Compliance							
Mechanical removal: Species Selective Electrofishing and trapping	This is mechanical removal of an on-going/larger scale that targets species brown trout. Any rapid response mechanical removal targeting SMB or other high priority new fish that hasn't occurred for 3 consecutive years or 5 total does not fall under this action but is allowed in this location under the CFMP rapid response mech action.	Any Harmful Non-native Aquatic Species	Spawning and congregation areas only	Glen Canyon NRA (not RM-12 Sloughs or BRT)	2	NPS	Expanded NNASMP
Brown Trout Mechanical Removal and Electrofishing in Glen Canyon Reach	This is mechanical removal of an on-going/larger scale nature that targets brown trout. Any rapid response mechanical removal targeting SMB or other high priority new fish does not fall under this action but is allowed in this location under the CFMP rapid response mech action.	Brown Trout	All	Glen Canyon Reach	3	NPS	Expanded NNASMP
Tributary Non-native Fish Control Electrofishing	NPS 2006c Experimental Actions Extended Additional Five Plus Years	non-native fish	Bright Angel Creek and Inflow FMZ	Grand Canyon National Park	1	NPS	CFMP
Boat-Electrofishing Trout Control	One Trip per Year in November	Trout	Bright Angel Creek and Inflow FMZ	Grand Canyon National Park	1	NPS	CFMP
Tributary Non-native Fish Control Electrofishing and or Angling	Applied up to 2.5 miles (4km) of stream during 2-3 Monitoring trips per year	Non-Native Species	Shinumo Creek and Inflow FMZ	Grand Canyon National Park	1	NPS	CFMP
Tributary Non-native Fish Control (netting/angling)	Incidental to Monitoring	Non-Native Fish	Havasu Creek and Inflow FMZ	Grand Canyon National Park	1	NPS	CFMP
Remove Brown Trout if captured during regular monitoring	Other trout species are not desirable in this reach and will not be purposefully managed there. Brown Trout are known predators of native fish and will be removed during regular fisheries monitoring.	Brown Trout	Lees Ferry	Any AZGFD monitoring location	N/A	AZGFD	Lees Ferry Fisheries ma
Selective and Non-Selective Barriers							
Placement of Selective Weirs to disrupt spawning	Placing of barriers where useful allowed	Any harmful NNAS	RM -12	Both Sloughs	1	NPS	Expanded NNASMP
Placement of Selective Weirs to Disrupt Spawning or New Invasions of Tributaries, Backwaters and Off-Channel Areas.	Placing of barriers where useful allowed	Any Harmful Non-native Aquatic Species	Backwaters, Off-channel ponds and Low Velocity Areas <5 acres; Tributaries	Glen Canyon NRA (not RM-12 Sloughs or BRT)	1	NPS	Expanded NNASMP
Placement of Selective Weirs to Collect or Restrict Non-native Aquatic Species Passage to Tributaries, Backwaters, and Off-Channel Areas	Placing of barriers where useful allowed	Any Harmful Non-native Aquatic Species	Small backwaters, off channel ponds, and low velocity areas < 0.5 ac: Tributaries	Grand Canyon National Park: Colorado River Mainstem and Tributaries	1	NPS	Expanded NNASMP
Non-Selective Barriers to Restrict access to Tributaries, etc.	Placing of barriers where useful allowed	Any harmful NNAS	RM -12	Both Sloughs	1	NPS	Expanded NNASMP
Placement of Non-Selective Barriers Restricting Non-native Aquatic Species	Placing of barriers where useful allowed	Any Harmful Non-native Aquatic Species	Backwaters, Off-channel ponds and Low Velocity Areas <5 acres; Tributaries	Glen Canyon NRA (not RM-12 Sloughs or BRT)	1	NPS	Expanded NNASMP
Placement of Non-selective Barriers Restricting Non-native Aquatic Species Access to Tributaries, Backwaters, and Off-channel Habitat Areas and Out-migration	Placing of barriers where useful allowed	Any Harmful Non-native Aquatic Species	Backwaters, Off-channel ponds and Low Velocity Areas <5 acres; Tributaries	Grand Canyon National Park: Colorado River Mainstem and Tributaries	1	NPS	Expanded NNASMP
Dewatering, dredging							

Table 1: Fisheries Actions within Current Compliance							
Dewatering Using High Volume Pumps	Tier 1 - potential for Incidental taking of life, if any fish collected beneficial use would be attempted if possible	Any harmful NNAS	RM -12	Upper Slough only	1	NPS	Expanded NNASMP
Dewatering Off-Channel Ponds and Small Backwaters Using High Volume Pumps	Tier 1 - potential for Incidental taking of life, if any fish collected beneficial use would be attempted if possible	Any Harmful Non-native Aquatic Species	Small backwaters, off channel ponds, and low velocity areas < 0.5 ac: Tributaries	Glen Canyon NRA (not RM-12 Sloughs or BRT)	1	NPS	Expanded NNASMP
Dewatering off-Channel Ponds or Backwaters Using High-Volume Portable Pumps	Tier 1 - potential for Incidental taking of life, if any fish collected beneficial use would be attempted if possible	Any Harmful Non-native Aquatic Species	Small backwaters, off channel ponds, and low velocity areas < 0.5 ac: Tributaries	Grand Canyon National Park: Colorado River Mainstem and Tributaries	1	NPS	Expanded NNASMP
Dredging to Connect Upper Slough to Lower Slough	This would connect the upper and lower slough only - does not include dismissed options of trying to channelize both sloughs.	Any harmful NNAS	RM -12	Upper Slough only	4	NPS	Expanded NNASMP
Weir Operations (Fall/Winter)	NPS 2006c Experimental Actions Extended Additional Five Plus Years		Bright Angel Creek and Inflow FMZ	Grand Canyon National Park	1	NPS	CFMP
Sonic guidance devices							
Sonic Guidance Devices in Backwater and Off-channel	Tier 1 action - no taking of life anticipated. Does not necessarily require additional consultation.	Any harmful NNAS	RM -12	Both Sloughs	1	NPS	Expanded NNASMP
Sonic Guidance Devices Used in Backwater and Off-channel Habitat Areas	Tier 1 action - no taking of life anticipated. Does not necessarily require additional consultation.	Any Harmful Non-native Aquatic Species	Backwaters, Off-channel ponds and Low Velocity Areas <5 acres; Tributaries	Grand Canyon National Park: Colorado River Mainstem and Tributaries	1	NPS	Expanded NNASMP
Sonic Guidance Devices in Backwater and Off- channel areas	Tier 1 action - no taking of life anticipated. Does not necessarily require additional consultation.	Any Harmful Non-native Aquatic Species	Small backwaters, off channel ponds, and low velocity areas <5 ac: Tributaries	Glen Canyon NRA (not RM-12 Sloughs or BRT)	1	NPS	Expanded NNASMP
Disrupt early life stages							
Mechanical Disruption of Early Life Stage Habitats at Specific Spawning Sites, including High-pressure Water Flushing and Mechanical Gravel Displacement	tier 2 - this would involve disrupting spawning using mechanical means.	Any Harmful Non-native Aquatic Species	Spawning areas only	Grand Canyon National Park: Colorado River Mainstem and Tributaries	2	NPS	Expanded NNASMP
Brown Trout Mechanical Disruption of Early Life Stages	tier 2 - this would involve disrupting spawning using mechanical means.	Brown Trout	Spawning Areas Only	Glen Canyon Reach	2	NPS	Expanded NNASMP
Mechanical Disruption of Early Life Stages	tier 2 - this would involve disrupting spawning using mechanical means.	Any harmful NNAS	RM -12	Lower Slough Only	2	NPS	Expanded NNASMP
Mechanical Disruption of Early Life Stages at specific spawning sites, including high-pressure water flushing and mechanical gravel displacement	tier 2 - this would involve disrupting spawning using mechanical means.	Any Harmful Non-native Aquatic Species	Identified spawning areas only	Glen Canyon NRA (not RM-12 Sloughs or BRT)	2	NPS	Expanded NNASMP
Chemical							
Application of Mollusk Repellents and Non-toxic Anti-fouling Paint	Tier 1 action - no taking of life anticipated. Does not necessarily require additional consultation.	Harmful Non- native Mollusks	Boat Hulls, Equipment and Water Infrastructure	Glen Canyon NRA and Grand Canyon NP	1	NPS	Expanded NNASMP

Table 1: Fisheries Actions within Current Compliance

			Only				
Application of Herbicides and Non-toxic Dyes to Backwaters	Tier 1 action - no taking of life anticipated. Does not necessarily require additional consultation.	Harmful Non- native Plants or Algae with High to Very High Risk	Backwaters, Off-channel ponds and Low Velocity Areas <5 acres; Tributaries	Glen Canyon NRA and Grand Canyon NP	1	NPS	Expanded NNASMP
Application of Registered Piscicides for Fishery Renovation of Tributary Streams with Natural Barriers (with mechanical removal and beneficial use in advance)	Higher Tier Actions require initiation of tribal consultation and this action would also require coordination with USFWS, AGFD and AZDEQ.	Any Harmful Non-native Aquatic Species	Tributaries with natural barriers only	Grand Canyon National Park: Colorado River Mainstem and Tributaries	2	NPS	Expanded NNASMP
(ammonia, oxygen, carbon dioxide, pH, etc.) (ammonia, oxygen, carbon dioxide, pH, etc.)	Higher Tier Actions require initiation of tribal consultation and this action would also require coordination with USFWS and AGFD and GCMRC and would need to have an approved study plan and research value.	Any Harmful Non-native Aquatic Species	Small backwaters, off channel ponds, and low velocity areas < 0.5 ac: Tributaries	Glen Canyon NRA (not RM-12 Sloughs or BRT)	3	NPS	Expanded NNASMP
Rapid Response Application of Registered Piscicides for New Invasive Non-native Fish (medium to very high risk) that Begin to Produce in Very Localized and Primarily Backwater or Off-channel Areas	Higher Tier Actions require initiation of tribal consultation and this action would also require coordination with USFWS, AGFD and AZDEQ.	Any new harmful NNAS rated medium to high risk	Small backwaters, off channel ponds, and low velocity areas <5 ac: Tributaries	Glen Canyon NRA (not RM-12 Sloughs or BRT)	3	NPS	Expanded NNASMP
Overwhelm Ecosystem-cycling Capabilities of Small Backwaters and Off-channel Areas (ammonia, oxygen, carbon dioxide, pH etc.)	Higher Tier Actions require initiation of tribal consultation and this action would also require coordination with USFWS, AGFD, ADEQ and GCMRC and would need to have an approved study plan and research value.	Any Harmful Non-native Aquatic Species	Small backwaters, off channel ponds, and low velocity areas < 0.5 ac: Tributaries	Grand Canyon National Park: Colorado River Mainstem and Tributaries	3	NPS	Expanded NNASMP
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	Higher Tier Actions require initiation of tribal consultation and this action would also require coordination with USFWS, AGFD and AZDEQ.	Any new harmful NNAS rated medium to high risk	Backwaters, Off-channel ponds and Low Velocity Areas <5 acres; Tributaries	Grand Canyon National Park: Colorado River Mainstem and Tributaries	3	NPS	Expanded NNASMP
Overwhelm Ecosystem-cycling Capabilities of Upper Slough	Higher Tier Actions require initiation of tribal consultation and this action would also require coordination with USFWS and AGFD and GCMRC and would need to have an approved study plan and research value. Note that this would not be used for Green sunfish per Expanded Errata notes (AGFD request).	Any harmful NNAS	RM -12	Upper Slough and possibly, Lower Slough	3	NPS	Expanded NNASMP
Rapid Response Application of Registered Piscicides for New NNAS	Higher Tier Actions require initiation of tribal consultation and this action would also require coordination with USFWS, AGFD and AZDEQ. Note that this would not be used for green sunfish in this location since it is no longer considered a rapid response in this location - per Expanded Errata notes (AGFD request).	Any NEW harmful NNAS but not GSF	RM -12	Both Sloughs	3	NPS	Expanded NNASMP
Application of Registered Piscicides for Long- term Control in Backwaters and Off-channel Areas for High or Very High-Risk Species Only	Higher Tier Actions require initiation of tribal consultation and this action would also require coordination with USFWS, AGFD and AZDEQ.	Any harmful non-native Aquatic Species rated high to very high	Backwaters, Off-channel ponds and Low Velocity Areas <5 acres; Tributaries	Grand Canyon National Park: Colorado River Mainstem and Tributaries	4	NPS	Expanded NNASMP
Application of Registered Piscicides for High and Very High Risk NNAS	Higher Tier Actions require initiation of tribal consultation and this action would also require coordination with USFWS, AGFD and AZDEQ.	High and Very High Risk NNAS	RM -12	Lower Slough Only	4	NPS	Expanded NNASMP

Table 1: Fisheries Actions within Current Compliance							
Application of Registered Piscicides for Control in Backwaters and Off-channel Areas for High and Very High-Risk Species Only	Higher Tier Actions require initiation of tribal consultation and this action would also require coordination with USFWS, AGFD and AZDEQ.	Any harmful non-native Aquatic Species rated high to very high	Small backwaters, off channel ponds, and low velocity areas <5 ac: Tributaries	Glen Canyon NRA (not RM-12 Sloughs or BRT)	4	NPS	Expanded NNASMP
Other							
Outreach/AIS prevention	Education public about non-native species	AIS	All	entire project area	1	NPS	CFMP
Expanded Non-Native Species Detection Monitoring	Expanded to Lower Colorado River, and Kanab and Havasu Creeks	Non-native species	all	entire project area	1	NPS	CFMP
Introduction of YY Male Brown Trout	Experimental - many steps before implementation would be considered	Brown Trout	All	Glen Canyon Reach	Experimental	NPS	Expanded NNASMP
Produce Small Scale Temperature Changes using a Propane Heater	Experimental - many steps before implementation would be considered	Any Harmful coldwater Non-native Aquatic Plants	Tributaries	Grand Canyon National Park: Colorado River Mainstem and Tributaries	Experimental	NPS	Expanded NNASMP
Introduction of YY Males of Medium to Very High- Risk Species (may be considered if brood stock exists)	Experimental - many steps before implementation would be considered	Any new harmful NNAS rated medium to high risk	Tributaries only	Grand Canyon National Park: Colorado River Mainstem and Tributaries	Experimental	NPS	Expanded NNASMP
Introduction of YY Male Green Sunfish or YY Males of Other Medium to Very High-Risk Species (may be considered if brood stock is available)	Experimental - many steps before implementation would be considered	Any new harmful NNAS rated medium to high risk	All	Glen Canyon NRA (not RM-12 Sloughs or BRT)	Experimental	NPS	Expanded NNASMP
Remove incidental captures	I.e., when monitoring this allows removal of non-native fish, but lower threat species could be thrown back, med-higher threat species removed and beneficial use used by NPS to the extent practical		all	entire project area	1	NPS	CFMP
Fisheries Monitoring - USGS-GCMRC-AZGFD, USFWS, NPS	Provides the compliance (NEPA and 106) for the fish handling actions related to the monitoring that agencies conduct on these projects.		Colorado River Mainstem FMZ	Grand Canyon National Park	1	NPS	CFMP
Mechanical Harvesting of Non-native Plants and Algae	Tier 1 action - no taking of life anticipated. Does not necessarily require additional consultation.	Harmful Non- native Plants or Algae	Backwaters, Off-channel ponds and Low Velocity Areas <5 acres; Tributaries	Glen Canyon NRA and Grand Canyon NP	1	NPS	Expanded NNASMP

Table 2: Existing Fisheries Specific Monitoring Trips (last updated Dec. 2022)

Months	Lead agency	Location/Trip	Number of Trips (per month)	Project Description	Status: Active? (Y/N, Maybe)
January					
	GCMRC	Lees BTELSS	2	Lees Ferry BTELSS- Juvenile Brown Trout Monitoring	Y
	GCMRC	Lees trout monitoring	1	Lees Ferry trout population monitoring	Y
February					
	GCMRC	Lees BTELSS	1	Lees Ferry BTELSS- Juvenile Brown Trout Monitoring	Y
March					
	AGFD	Lees fish monitoring	1	Lees Ferry fish population monitoring	Y
	BIOWEST	Grand Canyon Razorback seining trip	1		Maybe; check 2023 status
	GCMRC	Lees BTELSS	2	Lees Ferry BTELSS- Juvenile Brown Trout Monitoring	Y
April					
	AGFD	Grand Canyon Mainstem electrofishing/hoopnetting	1-2	Mainstem Fish, non-native (electro-fishing)-AZGFD	Y
	BIOWEST	Grand Canyon Razorback seining trip	1		Maybe; check 2023 status
	FWS	LCR HBC	1	LCR HBC, camps at three locations on Little Colorado River	Y
	GCMRC	Lees BTELSS	1	Lees Ferry BTELSS- Juvenile Brown Trout Monitoring	Y
	GCMRC	Lees TRGD	1	Lees Ferry trout population monitoring	Y
	NPS	Lees -12 mi slough netting	2		Y
May					
	BIOWEST	Grand Canyon Razorback seining trip	1		Y
	FWS	Grand Canyon LCR hoopnetting [LCR ONLY]	1	LCR HBC, camps at 4 locations on Little Colorado River	Y
	GCMRC	Lees BTELSS	1	Lees Ferry BTELSS- Juvenile Brown Trout Monitoring	Y
	GCMRC	Grand Canyon Juvenile HBC monitoring	1	Juvenile HBC monitoring-April 27 Launch downstream Lees Ferry. 4/23-27 Glen Canyon	Y
	NPS	Grand Canyon Havasu HBC monitoring [HAVASU ONLY]	1		Y
	NPS	Lees -12 mi slough netting	2		Y
June					
	BIOWEST	Grand Canyon Razorback seining trip	1		Maybe; check 2023 status
	GCMRC	Grand Canyon eDNA sampling	1	Environmental DNA Study	Y
	GCMRC	Grand Canyon LCR JCM [LCR ONLY]	1	LCR Juvenile HBC monitoring (3 camps)	Y
	GCMRC	Lees TRGD	1	TRGD	Y
	GCMRC	PIS (AQFB)	3	Grand Canyon Youth-"Partners in Science"	Y
	NPS	Grand Canyon Humpback Chub monitoring	1		N; starting 2023
	NPS	Lees -12 mi slough netting	2		Y
July					
	NPS	Lees -12 mi slough netting	2		Y
	GCMRC	Grand Canyon Juvenile HBC monitoring	1	Juvenile HBC monitoring	Y
	BIOWEST	Grand Canyon Razorback seining trip	1		Maybe; check 2023 status
	GCMRC	PIS; Grand Canyon Mainstem fish monitoring	1	Grand Canyon Youth-"Partners in Science"	Y
	AGFD	Lees fish monitoring	1	Lees Ferry trout pop. monitoring & targeted high risk NNF detection	Y
August					
	BIOWEST	Grand Canyon Razorback seining trip	1		Maybe; check 2023 status
	NPS	Lees -12 mi slough netting	2		Y
	NPS	Grand Canyon Humpback Chub monitoring	1		N; starting 2023
September					
	BIOWEST	Grand Canyon Razorback seining trip	1		Maybe; check 2023 status
	FWS	Grand Canyon LCR hoopnetting [LCR ONLY]	1	LCR HBC, camps at three locations on Little Colorado River	Y
	FWS	Grand Canyon Mainstem fish monitoring	1	Mainstem Fish, HBC- aggregations (netting)	Y
	GCMRC	Lees TRGD	1	Juvenile HBC Monitoring in Glen Canyon	Y
	NPS	Grand Canyon Havasu HBC monitoring [HAVASU ONLY]	1		Y
	NPS	Lees -12 mi slough netting	2		Y

October					
	AGFD	Lees fish monitoring	1	Lees Ferry trout pop. monitoring & targeted high risk NNF detection	Y
	FWS	Grand Canyon Western GRCA HBC monitoring	1	HBC monitoring below Diamond Creek	Y
	FWS	Grand Canyon LCR hoopnetting [LCR ONLY]	1	LCR HBC, camps at three locations on Little Colorado River	Y
	GCMRC	Grand Canyon Juvenile HBC monitoring	1	Juvenile HBC monitoring- Launch downstream 9/28. 9/24-27 Glen Canyon	Y
November					
	AGFD	Grand Canyon Below Diamond HBC monitoring	1	HBC monitoring from Pearce Ferry upstream	Y
	GCMRC	Lees TRGD	1	Lees Ferry fish population monitoring	Y
December					

Proposed List of 'Hotspot' Locations for Additional Monitoring to Address Increased Concern of Invasive Fish

Introduction:

Additional targeted monitoring trips should focus on hotspots identified by the cooperating fisheries agencies as containing adequate habitat and spawning locations for invasive fish. These locations were compiled through observation of previous captures of invasive cool- and warm-water fishes as well as local temperature and habitats. Table D.1. lists locations in Lees Ferry that are monitored two times per year by AGFD through electrofishing efforts. Additionally, given that water temperature in the Lees Ferry Reach were above 16C in 2022, and is forecasted to be above 16C from May to November in 2023 monthly mainstem monitoring in Lees Ferry may be necessary from March to November using a variety of methods including electrofishing, seining and trap netting. Table D.2. lists locations below the Paria River. The frequency of monitoring at the listed sites is variable. Several sites have historically been monitored twice a year by NPS but may be discontinued in 2023 due to lack of funding. It is recommended that monitoring of these sites, particularly high priority locations, continue.

Table D.1. Likely locations to investigate for presence of warm water invasive species in Lees Ferry; aka. 'hotspots'

RM/side	Location or habitat type	Priority	Currently monitored?	Agencies	Frequency
-15 to 0	mainstem LF	Med	Yes	multiple	multiple
-15.73/R	Below Dam Spillway	High	Yes	AGFD	2/year, July and October
-15.78/L	Below Dam Spillway	High	Yes	AGFD	2/year, July and October
-14.34/L	Spring	High	Yes	AGFD	2/year, July and October
-14.29/L	Rocky Shoreline	High	Yes	AGFD	2/year, July and October
-13.72/R	Spring	High	Yes	AGFD	2/year, July and October
-13.5/L	Spring	High	Yes	AGFD	2/year, July and October
-12.07/L	Slough: inside, along bar	High	Yes	AGFD, NPS, GCMRC	AZGFD 2/year July plus NPS multiple, GCMRC multiple
-12.07/L	Slough: along shore	High	Yes	AGFD, NPS, GCMRC	AZGFD 2/year July plus NPS multiple, GCMRC multiple
-12.2/L	Upper Slough	High	Yes	NPS	multiple plus pumpout
-11.02/R	Below Ferry Swale Bar	High	Yes	AGFD	2/year, July and October
-10.85/L	Rocky Shoreline	High	Yes	AGFD	2/year, July and October
-6.9/L	Backwater	High	Yes	AGFD	2/year, July and October
-3.32/L	Warm Spring	High	Yes	AGFD	2/year, July and October
-1.5/L	Backwater	High	Yes	AGFD	2/year, July and October
0-1/R	Mouth of Paria River	Low	No	AGFD	no targeted sampling, not good habitat

Table D.2. Likely locations to investigate for presence of warm water invasive species in the Grand Canyon below the Paria River; aka. 'hotspots'

RM/side	Location or habitat type[1]	Priority	Currently monitored?[2]	Agencies	Frequency
30/L	30-mile spring	Med	Unknown	FWS	HBC aggregation monitoring?
61/L	LCR and LCR inflow area	High	Yes	multiple	multiple
85/R	Clear Creek	Med	No		
88/R	Bright Angel Creek*	Med	Yes	NPS, FWS	Oct-Feb NPS weir and backpack, NPS June hoopnetting, NPS or FWS mainstem hoopnetting in summer
99/R	Crystal Creek*	Low	Yes	NPS HBC monitoring	Visual, 2/year
108.7/R	Shinumo Creek inflow*	High	Yes	NPS HBC monitoring	2/year
116.5/L	Elves Chasm*	Med	Yes	NPS HBC monitoring	Visual, 2/year
143.5/R	Kanab Creek*	High	Yes	NPS HBC monitoring	2/year
156.7/L	Havasu Creek inflow*	High	Yes	NPS HBC monitoring	4/year (2 creek trips, 2 mainstem aggregation)
183.5/R	below lava backwater*	Med	Unknown	NPS HBC monitoring	once/year
180-277	Western Grand Canyon Random Stratified sites	High	Yes	NPS/BioWest RZ monitoring	6/yr in spring/summer
204/R	Spring Creek*	Low	Yes	NPS HBC monitoring	once/year
209/L	209 Slough*	Med	Yes	NPS HBC monitoring	once/year
212/L	pumpkin springs	Low	Unknown	NPS or FWS	Visual, 2/year
225/L	Diamond Creek*	Med	Yes	NPS HBC monitoring	once/year

229&231	Travertine and Travertine Falls*	Low	Unknown	NPS HBC monitoring	visual occasionally when takeout at PF
243/R	RM243 backwater	High	Yes	NPS/BioWest RZ monitoring	6/yr in spring/summer
246/L	Spencer*	Med	Yes	NPS HBC monitoring	occasionally when takeout at PF
249/R	Surprise Canyon*	Med	Yes	NPS HBC monitoring	occasionally when takeout at PF
275/L	Columbine*	Low	Unknown	NPS HBC monitoring	occasionally when takeout at PF

1 These sites with an asterisk (*) have been monitored by NPS during translocation monitoring trips. These monitoring trips are scheduled to end due to loss of funding in 2023. These sites should be monitored periodically by restoring funding, or by another agency, and wrapped into existing trips if possible.
2 Status unknown as of January 2023 or dependent on funding availability.

Proposed Additional Monitoring to Address Increased Concern of Invasive Fish Species Below Glen Canyon Dam

Introduction

Invasive fish have been and will continue to be a challenge to the management of the Colorado River ecosystem (CRe) below the Glen Canyon Dam (GCD), and of special concern to listed species. Poor hydrologic conditions and warming temperatures exacerbate these challenges. For example, warming river temperatures below GCD, compounded by lower Lake Powell elevation releases, support habitat for many deleterious species including the smallmouth bass. The Strategic Plan (Plan) was written in response to the Secretary's Designee's Directive, which, in part, charged Reclamation, the Technical Work Group, and Grand Canyon Monitoring and Research Center to identify and propose monitoring efforts necessary to prevent, detect, and respond to cool- and warmwater invasive fish establishment below GCD. Monitoring effort recommendations in the Plan are further described in this attachment.

Proposed Monitoring Recommendations

(1) Expand existing monitoring efforts with flexibility to add additional days and survey locations.

(2) Conduct additional targeted monitoring trips.

Description of Monitoring Recommendations

1. Expand existing monitoring efforts:

The best means to determine the extent of the presence or establishment of invasive species is through monitoring efforts. This is best achieved by expanding the level of sampling and geographical extent of existing monitoring efforts. Existing monitoring trips could utilize personnel and equipment to monitor existing hotspots and new areas of concern on relatively short notice if flexibility allows the extension of the trip. The additional time would allow personnel to remove or address invasives detected without compromising the objectives of the trip. Depending on the nature of the existing trip, additional supplies, equipment, and trained personnel may be necessary to successfully expand the existing trip.

2. Conduct additional targeted monitoring trips:

Additional targeted monitoring trips should focus on hotspots identified by fisheries biologists as containing adequate habitat and spawning locations for invasive fish identified in Attachment D. In addition, if invasive fish have been detected previously, these trips could be used to address

those species. Additional invasive fish monitoring and targeted removal trip(s) could be conducted annually in the spring and fall that could occur over a 10–14-day period.

These additional, targeted monitoring trips would depend heavily on the availability of resources. If implemented, identified hotspots should be sampled with appropriate equipment such as seines, electrofishing backpacks, fyke nets, etc. Removals could occur during the monitoring trip as time and resources allow, but ultimately should not prevent completion of trip objectives (e.g., monitoring of designated, predetermined sites).

Data from the additional monitoring trips would be used by cooperating fisheries agencies to identify any additional actions needed and to inform the decision-making process outlined in Attachment A.

Hotspots and Areas of Concern:
Additional monitoring trips should target sites listed in Attachment D with locations in the Lees Ferry reach upstream to the dam, and the Colorado River mainstem and include the confluence of Shinumo and Kanab creeks when environmental conditions are favorable (i.e., DO, turbidity, water temperature, season, time of day). Information derived from the SMB-targeted short-term rapid response effort conducted in the Lees Ferry reach from October-December, 2022 could be used to inform future monitoring efforts (i.e., spring 2023). Furthermore, additional monitoring for young-of-year invasive fish species should be conducted during the late spring and summer through seining and other appropriate techniques.

Implementation considerations

The ability to increase monitoring efforts is limited by the capacity, resources, and personnel of the cooperating fisheries agencies. Additional resources will allow for more amply staffed and organized teams to facilitate sufficient data collection and efficient data processing, along with providing the flexibility for additional targeted monitoring trips. Increasing the amount of creel surveys could provide additional data to supplement monitoring efforts.

Increased funding within the existing interagency agreements and/or outside of GCDAMP funding for additional efforts will be necessary to accommodate the increasing concerns of invasive fish in the CRe.

Additional resources may also be found through contracting a third-party group to execute additional trips, or the development of volunteer programs such as youth educational trips to supplement the needs for additional personnel.

Supplemental Actions

to complement the Invasive Fish Species Below Glen Canyon Dam: A Strategic Plan to Prevent, Detect and Respond Report

This attachment includes options in addition to those included in the Strategic Plan, that could assist in invasive fish management that were proposed and/or discussed by members of the Smallmouth Bass Ad Hoc Group and cooperating agencies. However, these options may be worth further consideration, but will require more time beyond the initial development of this Plan to adequately evaluate their potential appropriateness and effectiveness. These options will require additional investigation to evaluate their potential appropriateness and effectiveness. They are documented here for future consideration.

Each supplemental action listed below is categorized by the time to implement and the length of time the effects would be expected. Additionally, the actions are categorized by that number of years that would be needed to implement; short-term actions are defined as implementable immediately or within approximately 1 to 2 years, mid-term actions within approximately 5 years, and long-term actions within approximately 10 years. Additional details regarding effectiveness, cost, and estimated time needed for design and compliance can be found in the Department of Interior documents specified in the table footnotes below. To date, the expected cost, design and compliance time are categorized relative to other actions identified in the table, and are preliminary estimates which are likely to change over time. A brief explanation for each supplemental action identified in the table is provided below.

Proposed Supplemental Actions Table

Action	Length of Action	Expected Cost*	Design Time*	Compliance Time*
Educational outreach	Long-term	Low	Short	Short
Modification of downstream spawning and nursery habitat [1]	Long-term	Low	Short	Short
Maintain Lake Powell elevation above 3560′	Varies	High	Mid	Mid
Temperature control device (TCD) [2]	Long-term	High	Long	Long
Add generation to bypass tubes [3]	Long-term	High	Long	Long

[1] U.S. Bureau of Reclamation, Upper Colorado Regional Office. 2018. Temperature Reduction Options for Glen Canyon Slough; RM -12. Technical Report No. SRH 2018-17.

[2] U.S. Bureau of Reclamation. 1999. Plan and draft Environmental Assessment for Glen Canyon Dam modifications to control downstream temperatures.

[3] U.S. Bureau of Reclamation. 1999. Plan of study adding for generation on the outlet works at Glen Canyon Dam.

* At this time, the expected cost, design time, and compliance are estimates which are relative to other actions listed in this table, as well as those identified in the Strategic Plan. Additional consideration is needed to define the associated costs and timelines to implement such actions.

Brief Summary of Actions

Educational outreach

While educational outreach is currently included in various programs and agency agreements, it is identified as a short-term action in the Strategic Plan (see section 3.3). Below are specific ideas focused on invasive fish species that are worth developing and including in educational outreach opportunities where possible.

- Create a forum to facilitate public reporting, such as a NPS-hosted Non-Native Aquatic Species EA webpage.
- Develop an 'app', or a project within iNaturalist or iMapInvasives, that can be used off-line to document and report an invasive fish species. Information could include the species, location, date, and disposition.
- Presentations and meetings with anglers to encourage notification when a targeted invasive species is detected. Notification would involve the 24/7 call-in report number, email address, and/or NPS- hosted form described above.
- Creel surveys could be an opportunity to better inform anglers and provide additional data to supplement monitoring efforts.

The described invasive fish species specific educational outreach could be implemented relatively quickly and with minimal cost, but would be less effective in the long-term when compared to other supplemental actions identified here. Associated responsibilities could be included in the rapid response coordinator position described in Attachment A: *Short-Term Rapid Response Actions*, which could include volunteer management/training, equipment management, communications/outreach, and in-field tasks, along with increased removal and expedited processing to allow for sufficient data reporting. Additional information regarding reporting of invasive species can be found in Attachment A: *Short-term Rapid Response Actions*.

Modification of downstream spawning and/or nursery habitat (i.e., the -12 mile slough)

Modification of habitat below GCD has been suggested as a means to prevent spawning and recruitment in Lees Ferry of undesirable warm water species from Lake Powell. In particular, the slough habitat at river mile -12 below GCD has provided spawning habitat for a variety of species over the years, including common carp, green sunfish, and smallmouth bass. This action was discussed, but not implemented through the NPS NNAS EA, and was evaluated in 2018 by Reclamation (USBR, 2018). Modification of the slough to prevent spawning of invasives could provide mid- to long-term benefits, but would require additional compliance and planning. Reclamation is pursuing a re-evaluation of potential modifications of the slough given the current environmental conditions and is expecting the report to be complete in June 2023.

Maintain Lake Powell elevations

Maintaining Lake Powell elevations, such that the risk of entrainment of the target invasive species is significantly reduced or eliminated could be an effective long-term solution to prevent invasive fish passage. However, this action is difficult to achieve in a short timeframe and would

require interagency coordination, favorable hydrology, as well as potential changes to water delivery. Ultimately, this action would fall under the scope and jurisdiction of Reclamation and the Colorado River Basin States, as upheld by the various Colorado River legal agreements.

Temperature control device (TCD)

In 2016, a Biological Opinion was issued by the US Fish and Wildlife Service, which included a recommendation that Reclamation investigate and consider temperature control modifications to the dam that would allow water to be drawn from different depths of Lake Powell. A TCD may allow for temperature control to prevent warmwater invasive fish establishment below GCD without the need to use bypass. Suggested temperatures and case studies have occurred at the Flaming Gorge Dam in efforts to control smallmouth bass (Bestgen, 2016 & Breton, 2015).

Add generation to bypass tubes

This action has been suggested as a potential mitigation measure to reduce hydropower impacts under specific operational alternatives which were presented at the August AMWG meeting to address the Secretary's Designee's Directive. Reclamation is exploring different modifications to the dam, but further discussion and evaluation is anticipated in the near future. The proposed operational flexibility currently being pursued by Reclamation would be used to prevent invasive fish establishment downstream using flow and temperature changes and may include extended use of the bypass tubes. Currently there is no ability to generate hydropower through the bypass tubes. Adding power generation to the bypass tubes at GCD would provide long-term benefits by reducing hydropower losses if the bypass tubes were used for extended durations. However, such a modification is dependent on structural integrity assessments. The time and cost to implement this action is significant and would require years of planning.

Re-introduction of Colorado Pikeminnow

Colorado pikeminnow historically played an important role as the top predator in the Colorado River ecosystem. Over a period of >3-million years, the Colorado river native fishes evolved behaviors and morphologies that limited their predation vulnerability to predation by Colorado pikeminnow (i.e., gape to body-depth relationships). Evidence from other co-evolved predator and prey species indicate that reintroduction of Colorado pikeminnow is unlikely to have adverse population-level impacts on co-evolved prey species. Complex interactions with native predators have been found to be important in mediating adverse impacts of non-native predators (Jokela et al. 2017, Glen et al. 2016), but top predators like the Colorado pikeminnow cannot fill the role of an apex predator if they are no longer present. Introduced sport fishes however, are likely to adversely impact endangered Colorado fishes. The absence of Colorado pikeminnow in the Lower Colorado River likely makes the ecosystem more vulnerable to continued invasion and establishment of introduced piscivorous fishes (Estes et al. 2011).

References:

Bestgen, K. R., & Hill, A. A. (2016). River regulation affects reproduction, early growth, and suppression strategies for invasive smallmouth bass in the upper Colorado River basin. Final report submitted to the Upper Colorado River Endangered Fish Recovery Program, Denver, Colorado. Department of Fish, Wildlife, and Conservation Biology, Colorado State University, Fort Collins. Larval Fish Laboratory Contribution, 187.

Breton, A. R., Winkelman, D. L., Bestgen, K. R., & Hawkins, J. A. (2015). Population dynamics modeling of introduced smallmouth bass in the upper Colorado River basin. Final report to the Upper Colorado River Endangered Fish Recovery Program, Denver, Colorado. Larval Fish Laboratory Contribution, 186.

Estes, J. A., Terborgh, J., Brashares, J. S., Power, M. E., Berger, J., Bond, W. J., & Wardle, D. A. (2011). Trophic downgrading of planet Earth. science, 333(6040), 301-306.

Glen, A. S., Pech, R. P., Davey, C., & Molsher, R. L. (2017). Raptors vs aliens: can indigenous birds of prey help control invasive predators?. New Zealand journal of zoology, 44(2), 99-107.

Jokela, A., Arnott, S. E., & Beisner, B. E. (2017). Biotic resistance of impact: a native predator (Chaoborus) influences the impact of an invasive predator (Bythotrephes) in temperate lakes. *Biological Invasions*, *19*(5), 1495-1515.

U.S. Bureau of Reclamation, Upper Colorado Regional Office. 2018. Temperature Reduction Options for Glen Canyon Slough; RM -12. Technical Report No. SRH 2018-17.

U.S. Department of the Interior. 2016. Final Environmental Impact Statement for the Glen Canyon Dam Long-Term Experimental and Management Plan.

Attachment G: Addendum to the Strategic Plan

Implementation Considerations provided by the SBAHG through the TWG, to the AMWG regarding next steps

January 2023

1. The Strategic Plan and attachments (hereafter, the Plan) should be adopted and utilized by Department of Interior (DOI) agencies to serve as a guiding framework and strategy for preventing, detecting, and responding to invasive fish below Glen Canyon Dam (GCD).

2. This Plan is not intended to curtail or restrict management agency actions already available under existing planning and compliance.

3. To make the Plan actionable, we recommend that the Secretary's Designee direct the DOI bureaus to adopt the Plan through an interagency Memorandum of Agreement or a similar agreement document, and reconvene the Smallmouth Bass Ad Hoc Group (SBAHG) through the GCDAMP TWG as necessary (i.e., when updates are warranted).

4. Additional funds will be necessary to address resource limitations for cooperating fisheries agencies to carry out future invasive fish actions in the CRe. The upcoming GCDAMP Technical Work Plan (TWP) planning process conducted by the Budget Ad Hoc Group (BAHG) should consider the additional monitoring and potential rapid response actions outlined in the Plan when prioritizing funding for 2024-2026. Reprioritization of funds within the GCDAMP may be necessary if external funds are not identified, however the current GCDAMP budget is limited and reprioritization may impact current and existing research projects. Therefore, it is recommended that additional funds outside of the GCDAMP be allocated to the actions mentioned in the Plan, or additional funding be incorporated into the GCDAMP budget.

5. The SBAHG should convene on an annual basis prior to BAHG TWP discussions to reevaluate current invasive fish actions to assess their effectiveness and consider available offramps. During this process, the SBAHG may also review and recommend updates to the Plan, as necessary.

Tribal Positions

From Kurt Dongoske, Pueblo of Zuni on 1/05/2023

As the Zuni THPO and on behalf of the Pueblo of Zuni, I have reviewed the submitted report, entitled "Invasive Fish Species Below Glen Canyon Dam: A Strategic Plan to Prevent, Detect, and Respond" developed by the both of you. Thank you for your efforts in drafting this plan.

I submit the following comments for your consideration. My comments are less technical, but rather more ethical in that they address what appear to me to be inconsistencies in the overall GCDAMP management objectives and how those management objectives continually disenfranchise and harm the Zuni people. Moreover, I understand that this report is in response to a directive issued by the Secretary's Designee and that the scope of the report is framed by the GCDAMP and various state management objectives.

First, I would like to address the wording in the report used to describe non-native fish as invasive, pests, and representing an "invasion" as troubling. From a Zuni perspective, all aquatic beings not only contain life, are sentient and thus are cherished and require protection by Zunis, but *are* Zuni relatives and children themselves, as taught by Zuni traditional history in and through *chimiky'ana'kowa*. The characterizations of smallmouth bass or any other aquatic life as "invasive," a "pest" or presenting an "invasion" is exceedingly inappropriate, highly disrespectful, and wholly nescient of Zuni relational life and lifeways. This fact has been continuously repeated to the Department of the Interior by Zuni through numerous letters signed by the Zuni Governor to the Secretary's Designee, the National Park Service, the Bureau of Reclamation, the U.S. Fish and Wildlife Service and the Grand Canyon Monitoring and Research Center over the past 15 years. Additionally, this Zuni perspective has been repeatedly vocalized at numerous Technical Work Group, Adaptive Management Work Group, and other meetings. The tone deafness of the Department of the Interior on this Zuni matter is very disconcerting.

The geographic scope of this plan is identified as "the Colorado River Ecosystem (CRe) as defined by the Glen Canyon Dam Long-Term Experimental and Management Plan (LTEMP) Record of Decision (ROD) as:

> *"... the Colorado River mainstream corridor and interacting resources in associated riparian and terrace zones, located primarily from the forebay of Glen Canyon Dam to the western boundary of GCNP. The CRe specifically consists of the area where dam operations impact physical, biological, recreational, cultural, and other resources. This section of the river runs through Glen, Marble, and Grand Canyons in Coconino and Mohave Counties in northwestern Arizona."*

I question how effective and pragmatic it is to manage this ecosystem as though it is separate from the greater environment of the Colorado Plateau in which it is situated. Efforts to perceive

and manage this ecosystem as though it is a "wilderness" and "natural" ecosystem when it is bookended by two dams and has over 30,000 visitors (not including the hundreds of scientists) traveling down river each year is idealistic. This idealism is further complicated by many of the GCDAMP stated management objectives which are in conflict. For example, a healthy rainbow trout fishery in Lees Ferry is of special commercial concern; however, rainbow trout downriver of the Paria are consider undesirable and a threat to native fish. It is also my understanding that largemouth bass, smallmouth bass, striped bass, walleye, channel catfish, and black crappie are consider "sportfish" in Lake Powell, but only become undesirable once they pass through the dam. In fact, my research indicates that in 1935 the U.S. Fish and Wildlife Service released largemouth bass into Lake Mead and over the subsequent 7 years black crappie, bluegill and green sunfish were added. Smallmouth bass is consider ubiquitous throughout the country and the credit for its wide range is due to intentional introduction and stocking as a sportfish; especially in the West. Human actions, past and present, have created the quandary that this program is now having to contend; the fish happen to be innocent victims and their destruction as a management action has reverberating adverse effects on the community of Zuni.

As Zuni Governor Panteah's expressed in his July 1, 2021, letter to the Biden-Harris administration: "[E]fforts to fulfill … obligations and responsibilities for meaningful considerations of Zuni human-environment and people-place relationships and direct, indirect, and cumulative adverse effects and impacts that may occur—and are occurring—to them reasonably and in good faith are repeatedly neglected. The norm for government agencies has been exclusionary, manipulated, and negligent applications of … regulations and procedures…. This in turn—whether wittingly or unwittingly—has been commonly and regularly used to perpetuate—if not reinforce—policies of inequity creation through bad faith approaches that result in racist programs and the simultaneous privileging … and reproduction of social, environmental, epistemic, and ontological injustices on and to Native peoples" (Panteah 2021:5).

The continued implementation of reactive management actions to undesirable fish below Glen Canyon Dam in the CRe that result in the destruction of these fish will continue to have negative psychological and emotional impacts on the Zuni community. Recent Western scientific studies have continuously demonstrated that emotional and psychological stress on the body can weaken immune systems and inflammatory response, cause the decline and dysfunction of the prefrontal cortex and the hippocampus, and even influence cancer incidence and cancer progression. The impacts of lethal management actions have farther reaching negative effects than those experienced within the defined CRe.

Given the above concerns, I believe the Pueblo of Zuni would be very supportive of the primary preventive measure recommended in your report which is to prevent fish from passing through Glen Canyon Dam. This is a position that the Zuni Governor, Tribal Council and religious leaders have repeatedly recommended to the National Park Service as a proactive measure, rather than continually being reactive by implementing lethal management actions.

Thank you for your consideration of the above comments. Should you have any questions please contact me at your earliest convenience.

From Jakob Maase, Hopi on 1/06/2023

Hopi's preference in concern of Smallmouth bass and other nonnative fish is for preventative and proactive actions as recommended in the report. Allowing for a foolish continuance of a problem is not fixing a problem. To quote Einstein "The definition of insanity is doing the same thing over and over and expecting different results."

The water levels and continued difficulties of climate change means new strategies need to be approached and that sacrifices of values on certain resources and discussion between institutions need to be made. This includes the Lake Powell side above the dam. The Colorado River is not a closed ecosystem between the dams.

If it must come down to it, then Hopi hopes that procedures can be done without the taking life and if further then taking of life un-needlessly (humans eating the fish, it going to something like an eagle sanctuary, etc. are preferred mitigation efforts if we have no further choice in our many, many options that we have been discussing over the long year.)

Thank you for your hard work and your consideration of Hopi's voice in the procedure of this management action.

I would also like to add that the Forebay Coldwater Barrier is top preference for Hopi in concern of preventing further nonnative fish intrusion from the Dam side.

THE HOPI TRIBE

Timothy L. Nuvangyaoma
CHAIRMAN

Craig Andrews
VICE-CHAIRMAN

February 23, 2023

Secretary of the Interior Designee Wayne Pullan and the AMWG Team
Upper Colorado River Regional Office
Bureau of Reclamation (BOR)
125 South State Street, Room 8100
Salt Lake City, UT 84138

RE: Hopi Tribe comments on the Framework to Prevent non-native Fish Species Establishment Below Glen Canyon Dam Addendum.

Dear Secretary of the Interior Designee Wayne Pullan and AMWG Team,

The Hopi Tribe is thankful for the opportunity to provide feedback on the *Framework to Prevent Invasive Fish Species Establishment Below Glen Canyon Dam.* This response expresses the Hopi Tribe's interests and positions on the Framework Plan. Therefore, we appreciate your agencies and the bodies of the AMWG and TWG for continuing solicitation of our input and your efforts to address this concern regarding the increase of smallmouth bass and other non-natives within the Colorado River ecosystem.

First, the Hopi Tribe made a covenant to be stewards of the land, including the Colorado River ecosystem. It is a tenant about being Hopi. In this regard, taking life should not be done lightly and only with proper consultation and mitigation measures. When taking of life cannot be avoided, beneficial use for human consumption and animal use (like the eagle sanctuaries) to the Hopi is an acceptable mitigation method.

The water levels and continued difficulties and impacts of climate change mean new strategies must be approached and considered. Sacrifices of values on specific resources and discussions between institutions must be made for all interested parties that benefit from the Colorado River. This includes the Lake Powell side above the dam. The Colorado River is not a closed ecosystem between the dams.

The Hopi Tribe prefers preventive methods foremost as they fulfill our stewardship responsibilities and prevent problems in the long term. This letter will discuss the options demonstrated within the plan from Hopi Tribe's perspective.

Mechanical Removal for non-natives:
For the Hopi Tribe, this method should not be the first alternative. The Tribe would like to explore preventive strategies to prevent non-native species from reaching the lower portions of the dam. If fish are to be removed in this manner, they are to be used for beneficial use. However, if mechanical fish removal is used as a rapid response, then proper mitigation for

unnecessary fish death must occur.

Harvesting/Angling:
Harvesting fish is acceptable if beneficial use is applied. In the past, the Hopi Tribe supported the elder/youth education harvesting/angling initiative. However, for both these options, the Hopi Tribe determined that treating the life taken with respect is a critical practice.

Electrofishing, Angling, Netting:
The Hopi Tribe opposes electrofishing because we understand that the method can harm native species. The Hopi Tribe benefited from electrofishing when fish was provided to the Tribe for consumption, however, this does not make it an acceptable method.

Selective and Non-Selective Barriers:
Barriers below the dam are acceptable when the conditions are right, such as increased water levels and the time of the season. Barriers above the dam should be a priority. The cold-water bay project barrier dam is an example of a fish barrier that would be acceptable in preventing fish from entering the river environment. Planned barriers that separate fish and redirect them are sufficient.

Dewatering/Dredging:
The Hopi Tribe wishes to avoid this method as an option entirely. It is destructive to the environment, harms fish, and is a needless taking of life.

Sonic Guidance Devices:
Auditory vibrations may affect the rest of the ecosystem. Vibrations in water and earth affect plants and animals; thus, the variables make this seem not a good choice.

Disrupt Early Life Stages:
Mechanical disruption of early life stage habitats at specific spawning sites, including high-pressure water flushing and mechanical gravel displacement, impacts the environment and the Hopi Tribe's values regarding all life. The Hopi Tribe requests consultation beforehand when this method is being considered and requires considerable analysis before the technique is considered for implantation. Interrupting the life process of any species is not a Hopi practice. Especially when conscious decisions are made, that will lead to death and is not an acceptable method for Hopi Tribe. Barriers that prevent spawning are sufficient. There are a lot of variables to each of these flow options.

Chemicals:
The Hopi Tribe finds these options inappropriate due to harm to other organisms and the ecosystem. There are a lot of negative variables that prevent beneficial use as mitigation.

Other:
The Hopi Tribe recommends outreach programs such as providing fish to Hopi communities for consumption.

Extended Monitoring:
It's a great idea, and more funding to the Hopi Tribe should be provided to implement this initiative.

Introduction of YY Male Brown Trout and Sun Fish:
The Hopi Tribe would like to avoid introducing other non-native species to the river ecosystem, which is counterintuitive to removing species below the dam. This is the type of idea that leads to further problems as nature takes its course.

Temperature Changes with a Propane Heater:
This process is an unknown method to the Hopi Tribe. The Tribe would like to request information on this technique.

Removal of Incidental Captures:
This is acceptable to the Hopi Tribe if beneficial use is in place.

Mechanical Harvesting of non-native plants and Algae:
The Hopi Tribe sees plants as living organisms. The Hopi Tribe interprets this as the unnecessary taking of life. Mitigation and outreach must take place to consider the impacts on the ecosystem.

Thank you for your continued consultation and inclusion of the Hopi Tribe in this decision-making process. The Hopi Tribe apricate the opportunity to comment and hopes you will take these comments seriously considering the plan options. Should you have any questions or need additional information, please contact me at Skoyiyumptewa@hopi.nsn.us.

Respectfully,

Stewart B. Koyiyumptewa
Program Manager/THPO
Cultural Preservation Office
The Hopi Tribe