United States Department of the Interior

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In reply refer to:
AESO/SE
2026-0053145-S7-001

August 13, 2026

Memorandum

To: Regional Director, U.S. Bureau of Reclamation, Interior Region 7, Upper Colorado Basin, Salt Lake City, Utah

From: Field Supervisor, U.S. Fish and Wildlife Service, Arizona Ecological Services Field Office, Phoenix, Arizona

Subject: Biological Opinion for Glen Canyon Dam Operations (2026–2036)

Thank you for your request for formal consultation with the U.S. Fish and Wildlife Service (FWS) pursuant to section 7 of the Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq.*), as amended (Act). We received your July 15, 2026, request for consultation via email on the same day. At issue are effects that may result from Bureau of Reclamation's (Reclamation's) proposed action to authorize 10 years of Glen Canyon Dam Operations in Coconino and Mohave counties, Arizona and Kane, Garfield, and San Juan counties, Utah. You concluded that the project "may affect and is likely to adversely affect" the endangered razorback sucker (*Xyrauchen texanus*), the threatened humpback chub (*Gila cypha*), and their designated critical habitats.

In your letter, you requested our concurrence with your determination that the proposed action "may affect but is not likely to adversely affect" the endangered Colorado pikeminnow (*Ptychocheilus lucius*) and its designated critical habitat, endangered bonytail (*Gila elegans*), endangered southwestern willow flycatcher (*Empidonax traillii extimus*), and the threatened western yellow-billed cuckoo (*Coccyzus americanus*). We concur with your determinations and include our rationales in Appendix A.

You also determined there would be "no effect" on bonytail critical habitat, the endangered Yuma Ridgway's rail (*Rallus obsoletus yumanensis*), endangered Sentry milk-vetch (*Astragalus cremnophylax* var. *cremnophylax*), threatened Mexican spotted owl (*Strix occidentalis lucida*) and threatened California condor (*Gymnogyps californianus*). "No effect" determinations do not require review from the FWS; therefore, we will not address bonytail critical habitat or these species further in this document.

We based this biological opinion on information in Reclamation's July 15, 2026, biological assessment (BA), the Final Environmental Impact Statement and Record of Decision, emails, telephone conversations, meetings, and other sources of information. Literature cited in this

biological opinion is not a complete bibliography of all literature available on the species of concern or on other subjects considered in this opinion. A complete record of this consultation is on file at this office.

Consultation History

- December 12, 2007: The FWS issued a biological opinion for Reclamation's Adoption of Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead (USFWS 2007). Reclamation committed to implement a conservation measure to control nonnative fish species in the mainstem of the Colorado River in Marble and Grand Canyons to reduce the threat posed to humpback chub.
- February 7, 2008: FWS issued a biological opinion for the Operation of Glen Canyon Dam (USFWS 2008). This biological opinion addressed further changes in operations from 2007. As a conservation measure, Reclamation committed to continue to control non-native fish species in the mainstem of the Colorado River in Marble and Grand Canyons to reduce the threat of predation on humpback chub.
- October 29, 2009: FWS issued a supplement to the 2008 biological opinion for the operation of Glen Canyon Dam (USFWS 2009).
- December 3, 2011: FWS issued a biological opinion for Operation of Glen Canyon Dam, High Flow Experiments and Non-Native Fish Control (USFWS 2011a).
- November 28, 2016: FWS issued the biological opinion for the Glen Canyon Dam Long-Term Experimental and Management Plan (LTEMP) (USFWS 2016a).
- December 18, 2020: Reclamation published a Review of the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead.
- December 17, 2021: Reclamation finalized the 5-year review of the humpback chub action triggers as developed for the LTEMP biological opinion (USFWS 2016a). The Action Triggers for the Management of Humpback Chub Colorado River, Grand Canyon (October 2021) document replaced the Proposed Action Triggers for the Management of Humpback Chub Colorado River, Grand Canyon (November 2015).
- June 24, 2022: Reclamation published a Notice of Intent (NOI) to Request Input on Development of Post-2026 Colorado River Reservoir Operational Strategies for Lake Powell and Lake Mead Under Historically Low Reservoir Conditions (87 FR 37884).
- July 12 and 14, 2022: Reclamation hosted two public webinars to discuss their request for public input on the Development of Post-2026 Colorado River Reservoir Operational Strategies for Lake Powell and Lake Mead Under Historically Low Reservoir Conditions.
- September 1, 2022: FWS provided comments to Reclamation on the Development of Post-2026 Colorado River Reservoir Operational Strategies for Lake Powell and Lake Mead Under Historically Low Reservoir Conditions.
- January 30, 2023: Reclamation published a Summary of Pre-Scoping Comments for Development of Post-2026 Colorado River Reservoir Operations and held a public

webinar to go over the report's contents.

- June 16, 2023: Reclamation published a NOI to Prepare an Environmental Impact Statement (EIS) and Notice to Solicit Comments and Hold Public Scoping Meetings on the Development of Post-2026 Operational Guidelines and Strategies for Lake Powell and Lake Mead (88 FR 39455).
- June 20, 2023: Reclamation provided a webinar for Basin Partners and Stakeholders providing a status update on the Development of Post-2026 Operations for Colorado River Reservoirs.
- July 14, 2023: Reclamation invited FWS to participate as a Cooperating Agency in the Preparation of an EIS for Developing Post-2026 Operational Guidelines and Strategies for Lake Powell and Lake Mead.
- July 26, 2023: FWS responded affirmatively to Reclamation's invitation to participate as a Cooperating Agency in the development and preparation of the proposed EIS regarding post-2026 operational guidelines and strategies for Lake Powell and Lake Mead (LCB-4000 2.1.4.17).
- August 15, 2023: FWS submitted formal comments to Reclamation on the NOI to address issues related to the Development of Post-2026 Operational Guidelines and Strategies for Lake Powell and Lake Mead and its compliance with the Endangered Species Act of 1973, as amended (Act), and the National Wildlife Refuge System Act (16 U.S.C. §668dd).
- October 24, 2023: Reclamation published a Summary of Scoping Comments for Development of Post-2026 Colorado River Reservoir Operations and held a public webinar to go over the report's contents.
- December 13, 2023: Reclamation developed and released the Post-2026 Operations Exploration Web Tool, an online platform that allows stakeholders, interested parties and the public to independently or collaboratively design, model and explore a wide range of creative operational strategies.
- April 29, 2024: FWS provided joint comments with the National Park Service (NPS) to Reclamation on their Colorado River Basin Post-2026 Operations Exploration Tool (on-line modeling tool).
- August 9, 2024: Reclamation met with the FWS's National Wildlife Refuge (NWR) program staff to discuss infrastructure concerns at NWRs in Arizona related to Post-2026 Colorado River flows.
- September 27, 2024: Reclamation provided FWS with a briefing on Reclamation's work to develop and model an EIS alternative responding to our April 29, 2024, comments.
- October 30, 2024: Reclamation submitted a Draft Resource Analysis Plan to FWS regarding the Post-2026 Colorado River Reservoir Operations EIS.
- November 13, 2024: FWS provided Reclamation with comments on the Draft Resource Analysis Plan via entries into a shared document online.
- December 05, 2024: Reclamation released a narrative of the EIS Alternatives for Post-

2026 Colorado River Reservoir Operational Strategies for Lake Powell and Lake Mead.

- April 9, 2024: FWS issued a final biological opinion to Reclamation for the Near-term Colorado River Operations Final Supplemental EIS: Glen Canyon Dam Operations.
- June 24, 2024: The FWS provided Reclamation with a consistency review of the biological opinion for the Glen Canyon Dam LTEMP (USFWS 2016a) concluding that implementation of "Cool Mix" flows fell within the project description and associated analysis.
- January 17, 2025: Reclamation released an Alternatives Report on Post-2026 Operational Guidelines and Strategies for Lake Powell and Lake Mead.
- February 20, 2025: Reclamation met with FWS's NWR program to identify and discuss Thresholds, River Stages, Zones or Elevation areas that are of specific interest to allow for a comparison of alternatives at those places so we can best describe and understand potential differences in effects. FWS also provided Reclamation with specific feedback in writing via email from each individual refuge.
- February 24, 2024: FWS provided Reclamation with feedback for the Section 106 analysis associated with Post-2026 EIS development.
- March 6, 2025. Reclamation provided FWS and the NPS with a briefing on the Decision Making in Deep Uncertainty briefing and training.
- April 4, 2025: FWS provided Reclamation with a list of questions and concerns related to how Post-2026 operations may interact with Colorado River Upper Initial Unit Storage reservoirs above Lake Powell.
- April 2025 – June 2026. FWS participated in monthly meetings with Reclamation and their contractors to discuss the Colorado River Upper Basin Post-2026 ESA process and analysis needs.
- September 2025–December 2025: Reclamation held Resource Action Team (RAT) meetings, FWS input summarized and emailed to Reclamation following RAT meetings and in review of the preliminary draft EIS.
- September 5, 2025: Reclamation provided FWS with a Summary Report on the 2024 implementation of Cool Mix Flow under the LTEMP SEIS.
- September 23, 2025: Reclamation released Chapter One of the Preliminary Internal Draft EIS for Post-2026 Colorado River Reservoir Operations Cooperating Agency review.
- September 24, 2025: Reclamation released Chapter Two of the Preliminary Internal Draft EIS for Post-2026 Colorado River Reservoir Operations Cooperating Agency review.
- September 29, 2025: FWS provided comments to Reclamation on the first two chapters of the Preliminary Internal Draft EIS for Post-2026 Colorado River Reservoir Operations.
- September 30, 2025: Reclamation provided FWS with briefings entitled Overview of Basin-wide Colorado River Reservoir Modeling and Overview of Post-2026 Draft EIS Alternatives.
- November 12–13, 2025. Reclamation provided FWS with Preliminary Internal Draft EIS

for Post 2026 Colorado River Operations for cooperating agency review.

- November 18, 2025: FWS provided comments to Reclamation on the Internal Preliminary Draft Post-2026 Operational Guidelines and Strategies for Lake Powell and Lake Mead Environmental Impact Statement, including appendices, as emailed on November 12 and 13, 2025.
- January 9, 2026: Reclamation released the Post-2026 Operational Guidelines and Strategies for Lake Powell and Lake Mead – Draft EIS on their website for public review.
- January 16, 2026: Reclamation published notice of the Draft EIS on the Post-2026 Operational Guidelines and Strategies for Lake Powell and Lake Mead in the Federal Register (91 FR 2131).
- March 02, 2026: FWS provided comments to Reclamation on the Draft EIS on the Post-2026 Operational Guidelines and Strategies for Lake Powell and Lake Mead as posted in the Federal Register (FR) notice on January 16, 2026 (91 FR 2131).
- May 8, 2026: Reclamation shared with FWS portions of the Preliminary Final EIS on Post 2026 Operational Guidelines and Strategies for Cooperating Agency review.
- May 15, 2026: FWS provided comments to Reclamation regarding preliminary Final EIS on Post-2026 operations. FWS requested that Reclamation limit the number of annual flow (hydrology) traces for the Biological Assessment (BA) to traces that reflect current conditions and reasonably anticipated traces in the next ten years considering the current best available science on increasing ambient temperatures, decreasing snowpack and decreased soil moistures.
- May 2026 – Present: FWS and Reclamation held frequent conversations, meetings and shared online correspondence regarding Section 7 consultation on the EIS for Post-2026 operations of Glen Canyon Dam.
- July 15, 2026: Reclamation initiated formal consultation and submitted a BA for the Post-2026 Colorado River Reservoir Operations (DOI 2026a).
- July 22, 2026. Reclamation sent FWS an email to clarify a discrepancy between the Section 7 determinations as worded BA and the cover letter.
- July 31, 2026: Reclamation finalized the Final EIS for the Post-2026 Operational Guidelines and Strategies for Lake Powell and Lake Mead (DOI 2026b).
- August 5, 2026: FWS provided Reclamation with a Draft Biological Opinion.
- August 7, 2026: Reclamation provided suggested edits to the Draft Biological Opinion, particularly regarding the proposed action since they finalized the Final EIS while we were working on the biological opinion.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

Regulations implementing the Act (50 CFR 402.02) define "action" as all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies of the United States or upon the high seas.

Reclamation provided a complete description of the proposed action in the BA (DOI 2026a), as well as revisions and corrections submitted during preparation of the biological opinion (see Consultation History), and other supporting information in the administrative record. We include these documents herein by reference but provide a summary of the proposed action below. This biological opinion will refer to elevation levels and water delivery (*e.g.*, million acre feet, cubic feet per second) in only English units because that is the standard terminology for this information. For other measures, the document will provide English and metric units.

Background

The Colorado River Storage Project (CRSP) is a system of federal dams and reservoirs authorized under the 1956 CRSP Act to manage water resources in the Upper Colorado River Basin (Upper Basin). Glen Canyon Dam is one of four CRSP units. Construction of Glen Canyon Dam was completed in 1963, and in 1980 the lake completed filling to the full pool elevation of 3,700 feet (ft). Operation of the dam is influenced by a complex set of compacts, federal statutes and regulations, court decrees, and an international treaty collectively and commonly referred to as the Law of the River.

Since 2000, the Upper Basin has been experiencing one of the worst multi-decadal droughts of the last 1,200 years (Gangopadhyay *et al*. 2022). In the early 2000s, falling reservoir elevations, together with the lack of objective criteria for managing the reservoirs at lower levels, prompted Reclamation to adopt the 2007 Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead (Interim Guidelines). The Interim Guidelines, which are in place for the interim period through Water Year (WY) 2026, provide operating criteria for Glen Canyon Dam and Hoover Dam, including provisions designed to provide a greater degree of certainty to water users about timing and volumes of potential water delivery reductions, and additional operating flexibility to conserve and store water in the system. The Interim Guidelines adopted ranges of releases from Glen Canyon and Hoover Dams that were linked to reservoir elevations in Lake Powell and Lake Mead, respectively. Since 2007, average annual flows have continued to decline, and flows have been significantly below average in nearly half of the years from 2008 to 2026 (DOI 2026a). Despite additional responsive actions to reduce the risk to the Colorado River system's critical infrastructure and water supplies, including the 2019 Colorado River Drought Contingency Plans (DCPs), storage in Lake Powell and Lake Mead continued to fall. Due to three consecutive years of below-average hydrology ending with this year's extreme dry hydrologic conditions (with the lowest snow-pack since the 1970's), in the spring of 2026, the Department of Interior (DOI) implemented extraordinary operational measures to protect critical infrastructure at Glen Canyon Dam and later this year (2026), the reservoirs are expected to reach their lowest elevations since filling.

Reclamation adopted the Interim Guidelines for a limited period (hence the name "Interim") to provide an opportunity for Reclamation and interested entities to gain valuable experience in the management of Lake Powell and Lake Mead under modified operations, with the goal of improving the analytical basis for making future operational decisions, whether during or after the interim period.

In 2016, Reclamation and the National Park Service (NPS) developed and implemented the Long-Term Experimental and Management Plan (LTEMP) for operations of Glen Canyon Dam (DOI 2016a). The LTEMP provides a framework for adaptively managing Glen Canyon Dam operations through 2036, consistent with the Grand Canyon Protection Act of 1992 and other provisions of applicable federal law. The LTEMP Environmental Impact Statement (EIS) provides a framework for managing dam operations, including hourly, daily, and monthly release patterns as well as non-flow, experimental, and management actions (DOI 2016a). In accordance with the normal operations as described in the LTEMP, a minimum of 8,000 cubic feet per second (cfs) must be released between 7 a.m. and 7 p.m., and a minimum of 5,000 cfs must be released between 7 p.m. and 7 a.m. The daily range in mean hourly flows is limited to 10 times the monthly volume in June through August and nine times the monthly volume in other months; under these rules, the daily range does not exceed 8,000 cfs. The up-ramp rate is limited to 4,000 cfs per hour, while the down-ramp rate is limited to 2,500 cfs per hour. An up-ramp rate is the speed at which dam operators increase water releases downstream. The up-ramp rate dictates how quickly spillway gates are opened or turbines are brought online. This controlled rate is used to prevent sudden flooding and protect infrastructure, as well as other purposes. The down-ramp rate is the speed at which dam operators decrease the amount of water being released downstream. The LTEMP Record of Decision (ROD; DOI 2016b) also allows for operational flexibility to adjust daily and monthly releases for water distribution purposes, resource-related issues, hydropower-related issues, and other circumstances. These could include safety of dams, public health, emergency situations, or unforeseen activities arising from operating experience including, in coordination with the Colorado River Basin States (Basin States), actions to respond to low reservoir conditions because of drought in the Colorado River Basin (Basin).

Proposed Action

The BA (DOI 2026a) describes the proposed action and environmental conditions that Reclamation would use to operate Glen Canyon Dam from WY 2027 through WY 2036. The biological opinion covers this same period (October 1, 2026, through September 30, 2036). The proposed action is based on a 10-year decision framework identified as the Preferred Alternative in the Final Environmental Impact Statement (FEIS; DOI 2026b) that establishes the operational principles, operational sideboards (*i.e.*, ranges for operational elements), and process that will govern development and issuance of operating guidelines at anticipated 2-year operating intervals through WY 2036. The number of years in an operating interval may be modified by DOI should consensus agreements or other factors warrant a different length of operating guidelines.

Operating guidelines are the objective criteria that will determine the operations of Lake Powell and Lake Mead. For each anticipated 2-year operating interval, the decision framework process will be carried out to develop and adopt operating guidelines in accordance with the operational principles and sideboards described below. Once issued, the operating guidelines will be in effect

until the end of each operating interval.

The decision framework does not establish specific operating guidelines; rather, it provides the structure within which operating guidelines will be developed, reviewed, and periodically updated. To analyze potential effects from a range of operating guidelines that may be issued during the 10-year period, Reclamation developed the "Representative Preferred Alternative", which is a set of modeling assumptions designed to capture the Preferred Alternative's operational sideboards (Table 1). The assumptions in Representative Preferred Alternative reflect how the Proposed Action was modeled to ensure analysis of the operational sideboards that will be in place through 2036; exact operations would adhere to the guidelines in place during each operating interval. The modeling assumptions do not represent implementation details (*e.g.*, use of projections), which will be identified as specific operating guidelines are developed through the decision framework process.

Preliminary modeling was performed for a set of anticipated operating guidelines covering the first operating interval, 2027–2028. While the exact operating guidelines for 2027–2028 are not established through the FEIS (DOI 2026b), the additional specificity provided by the assumptions in the preliminary modeling is instructive for inclusion in this biological opinion.

The Proposed Action is comprised of the 10-year decision framework, as analyzed through the Representative Preferred Alternative modeling assumptions, along with the modeling assumptions for the preliminary 2027–2028 operating guidelines. While specific operating guidelines will be identified for each operating interval, this combined set of modeling assumptions is a reasonable representation of Reclamation's anticipated future operations of Glen Canyon Dam. More information about the decision framework (operational principles, sideboards and process) and the preliminary 2027–2028 guidelines is provided below.

The decision framework (principles, sideboards, and process) will remain constant through WY 2036, unless it is modified through future federal action, seven-state consensus (referring to the seven Colorado Basin States), and/or environmental compliance (*i.e.*, NEPA, section 7 of the Act). The decision framework is guided by operational principles, which are fundamental objectives and considerations that reflect Reclamation's mandate to protect the Colorado River system infrastructure, acknowledge the Secretary's authority to operate the system and take protective actions when necessary, and attempt to reach consensus operations whenever possible. Elevating these principles ensures that operating guidelines adopted under the decision framework adhere to fundamental management priorities and provide a basis for review and reflection toward the end of each operating interval as new operating guidelines are developed. The decision framework's Operational Principles are as follows:

1. **Operations should be responsive to hydrology**. Annual operations and mid-year adjustments that account for evolving supply conditions should be adopted to ensure a flexible, adaptive approach to management.
2. **Critical federal infrastructure must be protected through practical and deliberate operations.** When Lake Powell is projected to fall below elevation 3,500 ft or when Lake Mead is projected to fall below elevation of 1,000 ft, processes and tools will be used to manage risks to infrastructure and prevent damage to federal facilities of regional and national importance. These elevations reflect current understanding of these facilities but

do not preclude the identification of alternate or additional critical elevations.

3. **Operating guidelines should implement the Long-Range Operating Criteria (LROC) while also providing directions to address extraordinary circumstances**. Operating guidelines will provide objective criteria for operating under low reservoir conditions within the bounds of the LROC but may also provide for temporary operational actions that are not otherwise provided for under the LROC when necessary to protect critical federal infrastructure in accordance with applicable federal law.
4. **Operating guidelines should prioritize consensus-based recommendations.** DOI will support efforts to achieve consensus agreements that appropriately provide benefits to multiple parties, that offer innovative, inclusive solutions to operational and management challenges, and that are sufficiently protective of the system. Should such agreements arise, they will be prioritized as new operating guidelines are developed and adopted. In the absence of consensus-based arrangements, the Secretary will take necessary management actions, consistent with applicable federal law.

The decision framework's Operational Sideboards (Table 1) consist of key thresholds and ranges for operational elements that create boundaries for the development of each set of operating guidelines and provide a basis for environmental compliance for the duration of the decision framework. The operational sideboards were chosen to ensure that the DOI would have flexibility and environmental compliance to operate in accordance with the operational principles given future hydrologic uncertainty (Table 1).

The process to develop operating guidelines will consist of reviews, consultations with key stakeholders and agencies, and opportunities for consensus building (Table 2). Assuming the anticipated 2-year operating interval, implementation is the expected focus during the first operating year. The second operating year includes both implementing the issued guidelines and completing the process to develop and issue subsequent operating guidelines. Reclamation will coordinate and consult with the seven Basin States throughout the interval as well as with Basin Tribes and partner agencies, Mexico, and other interested parties during key operational milestones. Reclamation may adjust the process if consensus-based agreements result in different operating interval. The specific operating guidelines for each operating interval over the 10-year term of the proposed action may differ.

Glen Canyon Dam Operations (and associated operations upstream)

Lake Powell WY releases would be based on the projected October 1 lake elevation.

The proposed action includes operations that include the Flaming Gorge, Navajo and Aspinall Upper Initial Unit (CRSP Upper Initial Units) releases as authorized in their respective RODs (DOI 2006a, 2006b, 2012a), and annual releases down to 5 million acre feet (maf) per year to protect Lake Powell's lower limit elevation. If Lake Powell's elevation is projected to go below 3,525 ft, CRSP Upper Initial Units may increase their releases within their RODs, contingent on hydrologic conditions and in consideration of their respective storage volumes. Reclamation would identify triggers for additional Upper Basin actions to protect critical infrastructure if needed. CRSP Upper Initial Units return to their normal annual operating targets when Lake Powell is no longer projected to go below 3,525 ft.

Lake Powell's primary WY release volume range is from 6 maf to 12 maf. To protect infrastructure at Glen Canyon Dam, if Lake Powell is projected to fall below 3,500 ft within the WY, the WY release may be reduced, subject to a minimum WY release of 5.0 maf. Additionally, this reduction would coincide with maximum practicable use of the CRSP Upper Initial Units within their respective RODs to protect critical infrastructure.

The proposed action does not analyze Lake Powell levels below 3,490 ft in elevation, the lowest lake level that penstocks can operate. However, severely dry hydrologic conditions may result in inflow so low that Reclamation is unable to maintain the critical 3,490 ft elevation and/or must take actions outside of the proposed action to protect the 3,490 ft elevation. Reclamation states in their BA that dam operations outside of the proposed action will require reinitiation of consultation (DOI 2026a). If any of these operations, or other operations that are not included within the Proposed Action, are possible based on 24-month study results or other planning processes, Reclamation will contact the FWS as soon as possible to discuss section 7 consultation needs. The regular 'check-ins' (August annual planning, April/May adjustments) will facilitate these discussions, but Reclamation will maintain frequent communication with the FWS regarding their hydrological modeling planning processes to ensure compliance under the Act.

Preliminary 2027–2028 Operating Guidelines

The modeling assumptions associated with these operations are within the decision framework operational sideboards and only applicable to WYs 2027 2028. Additional details are included in Appendix T of the FEIS (DOI 2026b).

Initial Water Year Release

The initial water year release is selected from a set of potential release volumes corresponding to the October 1 Lake Powell elevation as shown in Table 3. Potential release volumes are first evaluated to identify those projected to maintain a Lake Powell elevation of at least 3,510 ft during the following spring. The initial release is then selected from among those potential release volumes to preserve operational flexibility, allowing releases to be adjusted upward or downward over the course of the water year as hydrologic conditions evolve. The *Mid-Year Release Adjustments* section describes the potential adjustments to this initial water year release volume during the water year in response to changing hydrologic conditions. When the October 1 Lake Powell elevation is below 3,540 ft, the modeled implementation evaluates an initial water year release of 7.0 maf. If that release is projected to result in Lake Powell declining below elevation 3,510 ft, the determination of the water year release is deferred until April, and monthly releases are adjusted to maintain elevation 3,510 ft. In April, the water year release is set, likely between 6.0 and 7.0 maf, contemporaneously with the additional releases from CRSP Upper Initial Units to protect critical infrastructure at Glen Canyon Dam, as described in the *Mid-Year Release Adjustments* section, below.

Mid-Year Release Adjustments

There is potential for either an upward or a downward mid-year adjustment to the initial water year release. For modeling purposes, these adjustments occur in April of each year.

An upward adjustment occurs if the end of WY projected Lake Powell elevation exceeds elevation 3,565 ft. In this case, the initial water year release is increased by half of the projected storage above elevation 3,565 ft, up to a maximum water year release of 12.0 maf.

A downward adjustment is evaluated to reduce the risk that Lake Powell will decline below elevation 3,510 ft during the next spring. If the projected Lake Powell elevation in the spring is below 3,510 ft, the volume needed to maintain 3,510 ft is determined and used to adjust releases. First, the Lake Powell water year release is reduced to 7.0 maf if the initial release was greater than 7.0 maf. If additional reductions are necessary to meet the volume needed to maintain 3,510 ft, then the Lake Powell release is further reduced while CRSP Upper Initial Unit releases are increased. There is an attempt to maintain a 1:1 ratio between the additional Lake Powell release reductions and the increased CRSP Upper Initial Unit releases, subject to a maximum CRSP Upper Initial Units release of 1.0 maf and a minimum Lake Powell water year release of 6.0 maf. The *Infrastructure Protection and Other Considerations* section below describes the potential to reduce releases below 6.0 maf.

Coordination at High Elevations

For modeling purposes, a determination to potentially increase releases for the purpose of equalizing storage between Lake Powell and Lake Mead is made for the upcoming year if, on October 1, the net storage of all CRSP reservoirs exceeds the 602(a) storage volume and Lake Powell storage is greater than Lake Mead storage. Reclamation will compute the 602(a) storage volume using the parameters from the 2007 Final EIS (DO1 2007).

Infrastructure Protection and Other Considerations

If Lake Powell is projected to decline below elevation 3,510 ft during the current water year, annual releases may be reduced to as low as 6.0 maf. If Lake Powell is projected to decline below 3,500 ft elevation after these reductions are considered, WY releases may be further reduced to as low as 5.0 maf to protect critical Glen Canyon Dam infrastructure, subject to consultation with the Basin States. Monthly releases are adjusted to protect 3,510 and 3,500 ft subject to a minimum daily release established under LTEMP (DOI 2016a, b).

LTEMP and Sub-Annual Releases

As described in the “Background” section above, the LTEMP set parameters of sub-annual releases from Glen Canyon Dam. The LTEMP did not address annual operations for releases of less than 7.0 maf per year. Under this proposed action, monthly releases from Glen Canyon Dam would be distributed proportionally across the remaining months of the WY for annual releases below 7.0 maf while ensuring LTEMP minimum daily release rates are protected (Table 4). At this time, Daily Minimum and Average Maximum (cfs) values are estimates, and actual releases would vary. For example, weekend releases may have lower minimum releases to allow for higher releases on weekdays.

Conservation Measures

Reclamation currently implements conservation measures within the action area from the LTEMP Biological Opinion (USFWS 2016a) and Near-Term Colorado River Operations Final

Supplemental EIS Biological Opinion (USFWS 2024) (Table 5). Reclamation will continue to implement conservation measures from the LTEMP Biological Opinion (USFWS 2016a) for the life of action (2036). The Near-Term Colorado River Operations Supplemental EIS Biological Opinion (USFWS 2024) includes conservation measures that Reclamation will implement when the minimum probable scenario in the 24-Month Study shows Lake Powell dropping below 3,500 ft at any point in the following 12 months (Table 5).

Reclamation will work with the FWS, U.S. Geological Survey (USGS), and NPS over the next two years to evaluate these ongoing conservation measures to ensure they are meeting their intended goals. Any adjustments resulting from this evaluation will be incorporated into a future section 7 consultation(s) that cover(s) actions for both annual and/or sub-annual Glen Canyon Dam operations.

Additionally, as part of the Proposed Action, Reclamation would implement the following additional conservation measures. These additional conservation measures are designed to address warm water nonnative invasive fish entrainment and downstream production under lower Lake Powell elevations as tied to the proposed action. Should future conditions exist such that elevations remain high (*e.g.*, >3,565 ft) and release temperatures cool for an extended period (*e.g.*, <60.8 degrees Fahrenheit [°F;16 degrees Celsius (°C)] for 5 years), Reclamation will coordinate with the FWS to determine if any conservation measures can be reduced or are no longer necessary. As stated above, Reclamation will continue to implement conservation measures in the LTEMP Biological Opinion (USFWS 2016a) and the Near-Term Colorado River Operations Final Supplemental EIS Biological Opinion (USFWS 2024) (Table 5) as well as the conservation measures below that are intended to address entrainment, detection, and removal of warm water nonnative fishes below Glen Canyon Dam as well as measures to address temperature and razorback sucker translocations. These conservation measures address effects due to the proposed action on the above-described species and critical habitat.

Conservation Measures

Conservation Measures to Reduce Entrainment

- Glen Canyon Dam's Unit 1 penstock draws water from near "the shelf," an area that may provide habitat for nonnative fish and therefore represents the penstock most likely to entrain them. Reducing the amount of time Unit 1 operates may help decrease the number of fish entrained. Therefore, when Lake Powell's elevation is below 3,565 ft, Reclamation will limit operation of Unit 1 during the summer months (May–September) when Reclamation determines that conditions allow. Unit outages or emergency operational needs may still require its use.
- Reclamation will consider a method to deter fish movement into the Glen Canyon Dam forebay. Preventing nonnative fish entrainment through Glen Canyon Dam is critical to prevent establishment of these species below the dam. Reclamation may consider electric barriers, netting, and other methods. Use may be conditional (*i.e.*, removed when conditions are unfavorable to entrainment; for example, when the reservoir elevation is above 3,565 ft). Timing of this action will depend on environmental compliance, tribal

consultation, and funding constraints. Reclamation will provide quarterly progress updates to the FWS.

- Reclamation will design and implement a study in consultation with FWS to evaluate fish entrainment through Glen Canyon Dam. The study will be initiated by October 1, 2027.

Conservation Measures to Monitor (Detect) and Remove Warm water Non-native Fish

- Below Glen Canyon Dam—In accordance with the existing DOI Smallmouth Bass Rapid Response Charter (Charter), Reclamation will fund the development of a coordinated and comprehensive non-native fish monitoring (detection) and removal plan focused on the action area from Glen Canyon Dam to the confluence with the Little Colorado River (LCR). Reclamation will work with FWS, NPS, Grand Canyon Monitoring and Research Center (GCMRC), and Arizona Game and Fish Department (AZGFD) in their development of the plan. FWS and NPS will co-lead this group through development of the plan. The goal of the plan is to provide for a single, cohesive strategy that all partners use to ensure maximum efficiency and effectiveness. This plan will include management goals and objectives (*e.g.*, target species, triggers), robust monitoring and detection, strategic removal tactics, (*e.g.*, means, barriers/nets, chemical treatment, habitat manipulations), data management and analysis (*e.g.*, track CPUE to standardize and evaluate removal effectiveness and efficiency over time), and adaptive management and contingency planning (*e.g.*, annual reviews, strategy adjustments, establish permitting and approvals needed). The non-native fish monitoring and removal plan will be drafted by October 31, 2026, and finalized by December 15, 2026.
- Above Glen Canyon Dam—When Lake Powell water surface elevation is below 3,565 ft at any time during any of the months of May through October, Reclamation will work with the FWS, NPS, AZGFD, and other partners to investigate and implement non-native fish removal strategies in the Glen Canyon Dam forebay. Reclamation will coordinate with partners to begin this work by August 31, 2026.
- Reclamation will work with the FWS and NPS to investigate large-scale traps (*e.g.*, screw trap and/or a fish weir) in the river below Glen Canyon Dam. This would reduce the number of entrained smallmouth bass (*Micropterus dolomieu*) moving downstream. Reclamation will work with the FWS, NPS, and other partners and potential contractors to determine the feasibility of using large-scale traps by September 30, 2026. If Reclamation and partners determine a large-scale trap is feasible, installation of the recommended trap will be completed by August 30, 2027.
- Reclamation will work with the NPS, FWS, and Navajo Nation to investigate a potential fish weir or other barrier structures on the LCR to prevent the movement of non-native fish from the LCR into the mainstem Colorado River. Initial action is to purchase emergency fish exclusion gear (*e.g.*, custom fyke nets) no later than September 30, 2026. These nets can be placed near the downstream end of the LCR to block fish movement. Funds will also be set aside for staff the implementation and monitoring of this emergency gear when appropriate triggers are met. Reclamation will work with partners under the Charter to develop the trigger that will initiate the deployment of this emergency gear.

- In FY 2027, Reclamation will provide funding to pursue innovative tools for controlling non-native invasive fish. This may include exploring the development of trojan-male non-native species production or other emerging technologies. Reclamation will coordinate and consult with FWS, NPS, and AZGFD to prioritize funding efforts.
- Reclamation will fund efforts to better understand movements of non-native fish from below Pearce Ferry Rapid into the Grand Canyon. This monitoring will continue through 2031. If elevations rise to 1,080 ft at any point after this five-year period, monitoring will resume to improve understanding of the Pearce Ferry Rapid's effectiveness as a barrier.
- Under the Charter and in coordination and consultation with FWS, NPS, GCMRC, and AZGFD, Reclamation will support annual monitoring of backwater and other low-velocity habitats for non-native fishes and investigate potential operations that could lead to disruption of backwater habitat for warm water non-native fish.
- Under the Charter and in coordination and consultation with the FWS, NPS, GCMRC, and AZGFD, Reclamation will investigate the potential for altering backwater habitats, making them unsuitable or inaccessible to warm water non-native invasive species that compete with and predate upon native fish, including humpback chub and razorback sucker.

Temperature Control

- Reclamation will pursue measures to reduce river temperatures to disadvantage non-native invasive warm water species and benefit humpback chub, razorback sucker, and other native aquatic species. Reclamation will fund an appraisal-level design of a thermal curtain in the forebay and a temperature control device on Glen Canyon Dam, to be completed by December 31, 2029.

Translocation

- Reclamation will fund the NPS and FWS to stock razorback suckers in tributaries and mainstem reaches of the Colorado River in Marble and Grand canyons, and to monitor the outcomes of these efforts in alignment with the agencies' established plans and guidance. Stocking and translocations allow for opportunities to expand the area occupied by razorback sucker, augment the size and genetic diversity of populations, and improve the overall status of the species. Specifically, the following would occur:
    - Hatchery-raised razorback suckers will be stocked into areas within the LCR and other tributaries.
    - Monitoring of stockings will be conducted annually, or as needed depending on the data required to determine survivability, population status, or genetic integrity of the stocked population.

Action Area

The action area is defined at (50 CFR §402.02) as "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action." It is practical to treat the action area for a proposed federal action as the spatial extent of its direct and indirect

"modifications to the land, water, or air" (a key phrase from the definition of "action" at 50 CFR §402.02). Indirect modifications include those caused by other activities that would not occur but for the action under consultation. In delineating the action area, we evaluate the farthest reaching physical, chemical, and biotic effects of the action on the environment.

The proposed federal action area for the proposed action includes the Upper Colorado River from the full pool of Lake Powell at 3,700 ft elevation and extends downstream of Glen Canyon Dam for 296 miles (mi; 476 kilometers [km]) to Pearce Ferry Rapid (Figure 1). The action area includes the 100-year floodplain of the Colorado River downstream of Glen Canyon Dam through Glen, Marble, and Grand canyons, as well as the Lake Mead inflow from Grand Wash Cliffs to Pearce Ferry Rapid. The action area also includes the inflows of several tributary streams, as affected by flows of the mainstem Colorado River. This includes areas within the Paria River, LCR (about 0.25 mi [0.4 km]), Bright Angel Creek, Shinumo Creek, Tapeats Creek, Kanab Creek, Havasu Creek, and Spencer Creek.

ANALYTICAL FRAMEWORK FOR THE JEOPARDY AND DESTRUCTION OR ADVERSE MODIFICATION DETERMINATIONS

Jeopardy Framework

Regulations implementing the Act (50 CFR §402.02) define "jeopardize the continued existence of" as to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of the species. In accordance with our regulations (see 50 CFR §402.02, §402.14(g)), the jeopardy determination in this biological opinion relies on the following four components:

1. The *Status of the Species* evaluates the species' current range-wide condition relative to its reproduction, numbers, and distribution; the factors responsible for that condition; its survival and recovery needs; and explains if the species' current range-wide population retains sufficient abundance, distribution, and diversity to persist and retains the potential for recovery (see Endangered Species Consultation Handbook, March 1998, pp. 4-19 to 4-22).
2. The *Environmental Baseline* section of this biological opinion refers to the condition of the listed species without the effects caused by the proposed action to the listed species. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process to include impacts on listed species from Federal agency activities or existing Federal agency facilities that are not within the agency's discretion to modify. Thus, this section evaluates the past and current condition of the species in the action area relative to its reproduction, numbers, and distribution absent the effects of the proposed action, including the anticipated condition of the species contemporaneous to the term of the proposed action; the factors responsible for that condition; and the relationship of the action area to the survival and recovery of the species.

3. The *Effects of the Action* section of this biological opinion evaluates the direct and indirect effects on the species, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline.
4. The *Cumulative Effects* section of this biological opinion evaluates the effects of future State or private activities, not involving federal activities, within the action area of the federal action subject to consultation, on the species and its habitat, and how those effects are likely to influence the survival and recovery of the species.

In accordance with policy and regulation, the jeopardy determination is made by formulating the FWS's opinion as to whether the proposed federal action, including its effects, taken together with the status of the species, environmental baseline, and cumulative effects, reasonably would be expected to reduce appreciably the likelihood of both the survival and recovery of the species in the wild by reducing the reproduction, numbers, or distribution of that species.

Destruction or Adverse Modification Framework

Regulations implementing the Act (50 CFR §402.02) define "destruction or adverse modification" as a "direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species." Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features.

Older critical habitat designations used the term "primary constituent elements" (PCEs) to identify the key components of critical habitat that are essential to its conservation and may require special management considerations or protection. Revisions to the critical habitat regulations in 2016 (81 FR 7214–7440, 50 CFR §424) discontinued our use of the term PCEs and substituted the term "physical and biological features" (PBFs) to refer to these components, because the latter term is used in the statute. This shift in terminology does not change how the FWS conducts a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features.

In accordance with regulations (see 50 CFR §402.02, §402.14(g)), the destruction or adverse modification determination in this biological opinion relies on the following four components:

1. The *Status of Critical Habitat* section evaluates the condition of the critical habitat in terms of essential habitat features, primary constituent elements, or physical and biological features that provide for the conservation of the listed species; the factors responsible for that condition; and the intended value of the critical habitat for the conservation of the listed species (see Endangered Species Consultation Handbook, March 1998, pp. 4-19 to 4-22).
2. The *Environmental Baseline* section of this biological opinion, which refers to the condition of designated critical habitat without the consequences caused by the proposed action to the designated critical habitat. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process to include

impacts on designated critical habitat from Federal agency activities or existing Federal agency facilities that are not within the agency's discretion to modify. Thus, this section evaluates the past and current condition of the critical habitat in the action area absent the effects of the proposed action; including the anticipated condition of the critical habitat contemporaneous to the term of the proposed action; the factors responsible for that condition; and the conservation value of critical habitat in the action area for the conservation of the listed species.

3. The *Effects of the Action* section of this biological opinion evaluates all effects on critical habitat, direct, indirect, interrelated, and interdependent, and how those effects are likely to influence the conservation value of the affected critical habitat for the species in the action area.
4. The *Cumulative Effects* section of this biological opinion evaluates the effects on critical habitat of future State or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation, and how those effects are likely to influence the conservation value of the affected critical habitat for the species in the action area.

For purposes of making the destruction or adverse modification determination, the FWS evaluates if the effects of the proposed federal action on critical habitat, taken together with cumulative effects, when added to the current condition of critical habitat, are likely to impair or preclude the capacity of critical habitat to serve its intended function for the conservation of the listed species. The key to making this finding is clearly establishing the role of critical habitat in the action area relative to the value of critical habitat, and how the effects of the proposed action, taken together with cumulative effects, are likely to alter that role.

STATUS OF THE SPECIES AND CRITICAL HABITAT

Humpback Chub and Critical Habitat

The following information is a summary of the humpback chub's legal status, description and life history, habitat threats, distribution and abundance, and critical habitat.

Legal Status

The humpback chub, an endemic fish to the Colorado River Basin of the southwestern United States, was included in the List of Endangered Species issued by the Office of Endangered Species on March 11, 1967 (32 FR 4001). Under the Endangered Species Conservation Act of 1969 (16 U.S.C. 668aa) it was considered endangered. The humpback chub was included in the list of endangered and threatened species on January 4, 1974 (39 FR 1175). On November 17, 2021, the FWS reclassified the humpback chub from "endangered" to "threatened" with a 4(d) rule (86 FR 57588). FWS was able to reclassify the species to "threatened" because of the robust humpback chub populations in the LCR and western Grand Canyon. The status of Upper Basin humpback chub populations would not have supported the reclassification on their own (USFWS 2018a).

The FWS designated critical habitat in six reaches totaling 379 mi (610 km) of the Colorado River System on March 21, 1994 (59 FR 13374), including 198 mi (319 km) in the Upper Basin

and 181 mi (291 km) in the Lower Basin.

The first recovery plan for the humpback chub was approved in 1979 (USFWS 1979), the plan was revised in 1990 (USFWS 1990). Recovery Goals that amended and supplemented the 1990 revised plan were approved in 2002 (USFWS 2002a) but were withdrawn and declared of no force and effect by court order on January 18, 2006 (Grand Canyon Trust *et al*., vs. Gale Norton *et al.*, United States District Court for the District of Arizona, Order No. 04-CV-636-PHX-FJM).

The most recent and complete assessment for the humpback chub is the Humpback Chub Species Status Assessment (USFWS 2018a), which we used to inform this Status of the Species. FWS has conducted two, five year status reviews for the species (USFWS 2011b, 2018b).

Description and Life History

Using a hook and line, the humpback chub holotype (single physical specimen used to describe the species) was collected from the Colorado River at or near the mouth of Bright Angel Creek in Grand Canyon National Park (Miller 1946). The humpback chub is a member of the minnow family and may attain a total length (TL; length of the fish measured from the tip of the snout to the tip of the tail) of approximately 480 millimeters (mm; 19 inches [in]) and a weight of approximately 1.2 kilograms (kg; 3 pounds [lbs]) (Valdez and Ryel 1997). Juveniles have cylindrical bodies with a greenish back, silvery sides, and a whitish belly. Adults have an enlarged nuchal hump that rises abruptly behind the head and a laterally compressed body that is fusiform and tapered toward a slender tail. The back and sides are grayish green fading to a whitish belly. The scales are small and deeply embedded, sparse toward the back, and absent from the nuchal hump and belly. The fins are large and falcate, and the tail is deeply forked. Spawning adults develop small tubercles on the head and paired fins; and the gill coverings, paired fins, anal fin, and belly become tinged with orange. Humpback chub frequently can live to an age of over 20 years, with longevity of approximately 40 years (USFWS 2018a).

The humpback chub is a spring-time communal spawner that broadcasts and fertilizes its eggs on rocky substrates. Humpback chub spawn in seasonally-warmed rivers and tributaries. Spawning takes place in spring along river margins and on mid-channel bars with boulder, cobble, and clean gravel substrate. In the upper basin, adults usually spawn in April–July, during or immediately after the peak of spring runoff and with no detectable movement to specific locales (Valdez and Clemmer 1982, Kaeding *et al*. 1990). In the Grand Canyon, adults spawn in March–April after moving less than 15 km (9 mi) from the colder Colorado River to the seasonally-warmed LCR (Valdez and Ryel 1995), where they move up to 14 km (8.6 mi) upstream (Douglas and Marsh 1996, Van Haverbeke *et al*. 2013). There is also recent evidence of mainstem spawning in western Grand Canyon (Rogowski *et al*. 2018).

A single humpback chub female releases approximately 2,500 eggs into the water column where they are fertilized by male humpback chub as they settle into interstitial spaces where water circulation keeps the semi-adhesive eggs aerated (Hamman 1982). The humpback chub broadcasts eggs on rocky substrate; the fertilized eggs swell and become semi-adhesive as they lodge in the crevices and interstitial spaces of the substrate (USFWS 2018a). There is little evidence of long-distance larval drift, but the larvae are carried passively by currents to nearby sheltered shorelines consisting of boulders, cobble, and gravel (Valdez 1990, Robinson *et al*.

1998). Humpback chub develop from the larval stage to age-0 at approximately 25 mm (1 in) TL or 30–40 days of age (Hamman 1982, Muth 1990).

The timing and age for humpback chub development are largely temperature dependent, with fish in warm habitats reaching maturity in 3–4 years, whereas fish in the colder Colorado River in Grand Canyon may require 8–15 years to reach maturity (Coggins and Pine 2010, Yackulic *et al*. 2014). For monitoring purposes, humpback chub greater than 200 mm (7.9 in) TL are considered adults (USFWS 2018a).

Habitat

Adult humpback chub use deep pools and large eddies, and they consume a variety of foods. Adults use offshore habitats, including large recirculating eddies and deep pools where they feed, but they can move to feed in shallow complex shoreline habitats at night or during periods of moderate to high turbidity (Valdez 1990, Valdez and Ryel 1995, Chart and Lentsch 1999). Adults may move daily within large recirculating eddy complexes (Gerig *et al*. 2014). Adults in the LCR and those translocated to other tributaries (Shinumo and Havasu creeks) also use the deepest pools available (Healy *et al*. 2014, Nelson *et al*. 2016).

Age-0 humpback chub use rocky complex shorelines of boulders, talus, cobble, and vegetation where they hide in interstitial spaces during the day and emerge to feed under reduced light (Converse *et al*. 1998, Korman *et al*. 2004). Age-0 fish may also be found in sandy backwaters of the Grand Canyon, although this feature comprises a small portion of available habitat in canyon reaches (Ackerman 2008, Dodrill *et al*. 2015). Age-0 humpback chub transition into the juvenile stage at 1 year of life, or at approximately 40 mm (1.6 in) TL.

Juvenile humpback chub in the Upper Basin use rocky complex habitat, often along shorelines, and they move to increasingly deeper offshore areas of large boulders and cobble with increasing size and age (Karp and Tyus 1990, Valdez *et al*. 1990, Chart and Lentsch 1999). Juveniles in the Colorado River in Grand Canyon use rocky talus shorelines where they move up-slope and down-slope to maintain position with depth and velocity under changing water levels from dam operations (Converse *et al*. 1998, Trammell *et al*. 2002, Korman *et al*. 2004). Juveniles in the mainstem may also use backwaters, but this habitat feature is rare, ephemeral, and usually contains a small portion of the overall number of juveniles in the system (Dodrill *et al*. 2015). In the LCR, juvenile humpback chub use deep mid-channel pools and chutes with large boulders and cobble (Stone and Gorman 2006). Juvenile humpback chub are most active during mornings and evenings under low light conditions, and during flooding when turbidity is high (Valdez and Ryel 1995).

Although the humpback chub is a warm water adapted species, there may be benefits to later stages from cooler temperatures. Growth in the cooler Colorado River in Grand Canyon is slower than in the LCR, but individuals in the mainstem live longer (Yackulic *et al*. 2014), have better body condition (Meretsky *et al*. 2000), and carry fewer parasites (Hoffnagle *et al*. 2006). Cooler mainstem temperature limits development and reproduction of the Asian tapeworm and the parasitic copepod, Lernaea, which are common warm-water parasites of the humpback chub (Hoffnagle *et al*. 2006).

Threats

Primary threats to the species include streamflow regulation and habitat modification from large dams, and competition with and predation by warm water non-native fish species (USFWS 2018a). Upper basin habitat, including channel geomorphology and water temperature have not changed appreciably, but spring peak flow has been reduced and summer and winter base flows have increased. Habitat in the Grand Canyon has been modified by the presence and operation of Glen Canyon Dam, including altered flow and temperature regimes and sediment budget. Predation and competition by non-native fishes is likely the greatest threat to humpback chub in both the Upper Basin and Lower Basin populations. The highly predacious smallmouth bass may be the greatest non-native threat to humpback chub because smallmouth bass can co-occur with humpback chub and is a potential predator across all life stages (Haines and Modde 2007, USFWS 2018a, Schmidt *et al*. 2024, Bruckerhoff *et al*. 2025, Eppehimer *et al*. 2025, Pine *et al*. 2025, Bestgen *et al*. 2026).

Distribution and Abundance

The humpback chub is endemic to canyon-bound warm-water habitats of the Colorado and Green Rivers. Historical and recent collections have documented humpback chub in Arizona, Colorado, Utah, and Wyoming (USFWS 2018a). The exact historical distribution for humpback chub is not known (USFWS 2018a). Humpback Chub occurred in the Colorado River from the Black Canyon near present-day Hoover Dam, upstream to Debeque Canyon, Colorado; the Green River to the Blacks Fork River, Wyoming; and the Yampa River through Cross Mountain Canyon, Colorado (USFWS 2018a). Currently humpback chub occur in three populations upstream of Lake Powell in the Upper Basin (Black Rocks/Westwater Canyon, Desolation/Gray canyons, and Cataract Canyon), and two self-sustaining populations in the lower basin (Western Grand Canyon and LCR/Grand Canyon East). Since 2003, federal agencies have also translocated humpback chub into three tributaries (Bright Angel Creek, Havasu Creek, and Shinumo Creek) within the Grand Canyon (Omana Smith *et al.* 2022). A documented extirpation of humpback chub occurred at Dinosaur National Monument, likely caused by multiple flow related stressors after the construction of Flaming Gorge Dam (USFWS 2018a). Possible extirpation also occurred in Black Canyon and Hideout Canyon after riverine habitat became inundated by the reservoirs. Finally, the Cataract Canyon population is reduced from its historical extent due to inundation from Lake Powell.

Critical Habitat

FWS designated critical habitat for humpback chub in 1994 in seven reaches for a total of 379 mi (610 km) (59 FR 13374). There are 198 mi (319 km) of critical habitat in the Upper Basin (Colorado and Utah) and 181 mi (291 km) in the Lower Basin (Arizona). In Arizona, critical habitat includes 173 mi (278 km) of the Colorado River through Marble and Grand Canyons (Reach 7) from Nautiloid Canyon (RM 34) to Granite Park (RM 208), and the lower 13 km (8 mi) of the LCR (Reach 6). The entire Colorado River reach in Arizona and the bottom portion of the LCR are within the action area.

Critical habitat was designated for the four big river fishes (Colorado Pikeminnow [*Ptychocheilus lucius*], humpback chub, bonytail [*Gila cypha*], and razorback sucker)

concurrently in 1994, and the PBFs were defined for the four species as a group (59 FR 13374). However, the PBFs vary somewhat for each species on the ground, particularly regarding physical habitat, because each of the four species has different habitat preferences. The PBFs are:

- Water: Consists of water of sufficient quality (*i.e*., temperature, dissolved oxygen, lack of contaminants, nutrients, turbidity, *etc*.) that is delivered in sufficient quantity to a specific location in accordance with a hydrologic regime that is required for the specific life stage for each species.
- Physical Habitat: This includes areas of the Colorado River system that are inhabited by fish or potentially habitable for use in spawning, nursery, feeding, or corridors between these areas. In addition to river channels, these areas include bottomlands, side channels, secondary channels, oxbows, backwaters, and other areas in the 100-year floodplain, which when inundated provide spawning, nursery, feeding, and rearing habitats, or access to these habitats.
- Biological Environment: Food supply, predation, and competition are important elements of the biological environment and are considered components of this constituent element. Food supply is a function of nutrient supply, productivity, and availability to each life stage of the humpback chub. Predation, although considered a normal component of this environment, is out of balance due to introduced fish species in some areas. This is also true of competition from non-native fish species.

The PBFs are all integrally related and must be considered together. For example, the quality and quantity of water affect the food base directly because changes in water chemistry, turbidity, temperature, and flow volume all affect the type and quantity of organisms that can occur in the habitat that are available for food. Likewise, river flows and the river hydrograph have a significant effect on the types of physical habitat available. Changes in flows and sediment loads caused by dams may have affected the quality of nearshore habitats that young humpback chub use. Increasingly the most significant PBF seems to be the biological environment, and in particular predation and competition, from non-native species. Even in systems like the Yampa River, where the water and physical PBFs are relatively unaltered, non-native species have had a devastating effect on the ability of that critical habitat unit to support conservation (Finney 2006, Haines and Modde 2007, Fuller 2009, USFWS 2018a, Schmidt *et al*. 2024, Bruckerhoff *et al*. 2025, Eppehimer *et al*. 2025, Pine *et al*. 2025, Bestgen *et al*. 2026). It is likely that the future conservation of humpback chub will depend on our ability to control non-native species, and manipulating the water and physical PBFs of critical habitat to disadvantage non-natives may play an important role.

Previous Consultations

A list of consultations affecting this species is available on the Environmental Conservation Online System web platform.

Razorback Sucker and Critical Habitat

The following information is a summary of the razorback sucker's legal status, description and life history, habitat threats, distribution and abundance, and critical habitat.

Legal Status

The FWS first proposed the razorback sucker for listing under the Act on April 24, 1978 (43 FR 17375), as a threatened species. The proposed rule was withdrawn on May 27, 1980 (45 FR 35410), due to changes to the listing process because of the 1978 amendments to the Act. Following receipt of a petition in 1989 to list the razorback sucker, the FWS listed the razorback sucker as an endangered species on November 22, 1991 (56 FR 54957). FWS designated critical habitat for the razorback sucker in 1994 (59 FR 13374).

On July 7, 2021, FWS published a proposed rule to reclassify the razorback sucker as threatened with a 4(d) rule (86 FR 35708). The FWS published the final rule to reclassify the razorback sucker from endangered to threatened with a 4(d) rule on July 17, 2026 (91 FR 44756). The final rule will not take effect until August 17, 2026; therefore, at this time, the razorback sucker is still classified as endangered.

FWS completed the initial recovery plan for the razorback sucker in 1998 (USFWS 1998). Recovery goals that amended and supplemented the 1998 plan were approved August 1, 2002 (USFWS 2002b). Downlisting criteria required genetically and demographically viable, self-sustaining razorback sucker populations in the Green River subbasin and either the Colorado River subbasin or the San Juan River subbasin, a genetic refuge in Lake Mohave, and two genetically and demographically viable, self-sustaining populations in the lower basin. Delisting required population improvements for three consecutive years, post-downlisting.

The most recent and complete assessment for the razorback sucker is the Species Status Assessment Report for the Razorback Sucker (USFWS 2018c), which we used to inform this Status of the Species. FWS has conducted two, five year status reviews for the species (USFWS 2012, 2018d).

Description and Life History

The razorback sucker is the only representative of the genus *Xyrauchen* and was described from specimens taken from the "Colorado and New Rivers" (Abbott 1861) and Gila River at Fort Thomas in Arizona (Kirsch 1889). This native sucker is distinguished from all others by the sharp-edged, bony keel that rises abruptly behind the head. The body is robust with a short and deep caudal peduncle (Bestgen 1990). The razorback sucker may reach lengths of 3.3 ft (1.0 m) and weigh 11 to 13 lbs (5.0 to 5.9 kg) (Minckley 1973). Razorback suckers are long-lived, with some adults reaching the age of at least 50 years (Marsh *et al.* 2015). Razorback suckers hybridize with flannelmouth sucker (*Catostomus latipinnis*) where the species overlap, these hybrids are generally morphologically intermediate, and the keel is more variable (Wolters *et al*. 2019).

Razorback suckers take 2–6 years to reach maturity, depending on rearing habitat, which equates to 14 to 18 in (350–450 mm) TL or greater (Bestgen 1990, Albrecht *et al*. 2009). The razorback sucker's spawning season varies between basins. In Upper Basin riverine habitats, ripe razorback sucker has been collected from mid-April to mid-June (4–5 weeks) when temperatures reach 57 to 61°F (14–16°C) and springtime flows peak (USFWS 2018c). In lotic environments where higher spring flows connect backwater and floodplain habitats, adult razorback suckers move

into these habitats that are typically 3.6–7.2°F (2 –4°C) warmer than the main channel. In lentic Lower Basin habitats, spawning generally occurs between January and April when water temperatures are typically 50–68°F (10–20°C) or higher (USFWS 2018c).

Razorback sucker females lay eggs on clean, rocky substrates and are adhesive after fertilization (USFWS 2018c). After hatching, larvae feed on benthic insects (*e.g*., chironomids), zooplankton, and phytoplankton. Hatchling growth and survival is dependent upon adequate food resources (Marsh and Langhorst 1988, Bestgen 1990). As larvae transition to juvenile fish, they can occur in both lentic and lotic environments.

Successful razorback sucker egg incubation occurs at water temperatures from 49–68°F (9.5–20 °C) (USFWS 2018c). Fluctuating water levels, wave action, suffocation due to silt deposition, non-native predation, and low dissolved oxygen and high salinity are all causes of egg fatality.

Snyder *et al.* (2004) describe the transition from larvae to juvenile as beginning at 1–1.2 in (27–30 mm) TL and ending at 1.3–1.4 in (32–35 mm) TL. The juvenile razorback sucker life stage ranges from 1.3–17.7 in (27–450 mm) TL depending on capture location and fish origin. Generally, in the Upper Basin, razorback suckers greater than 13.8 in (350 mm) TL are sexually mature (Muth *et al.* 2000).

Dispersal of razorback sucker larvae from spawning bars in rivers occurs during high spring runoff flows. Drifting larvae are more likely to survive if they drift into floodplain wetlands, which are food-rich and protected from predators (Muth *et al.* 2000). Success can depend on the magnitude and duration of spring discharge, proximity to and interaction with floodplains, water temperature and variability, geomorphic factors, and turbidity (USFWS 2018c).

Habitat

The Species Status Assessment Report for the Razorback Sucker contains detailed habitat information for all razorback sucker life stages (Table 1 in USFWS 2018c).

Historically, razorback sucker occurred in most components of low velocity riverine habitat, such as backwaters, floodplains, sloughs, oxbow lakes, and other slackwater habitats within the main channel (USFWS 2018c). Reaches in the Upper Basin typically consist of higher-gradient, erosional, dynamic sections, whereas Lower Basin riverine habitats are more depositional, channelized, homogenous habitat types occasionally interspersed with highly vegetated, perennial, and permanently connected man-made off-channel backwater and floodplain impoundment structures (Bradford and Gurtin 2000). Seasonally submerged off-river habitats including bottomlands and other marsh-like, lowland habitats likely were important habitat for razorback suckers prior to the construction of mainstream dams (Tyus and Karp 1989, Bestgen 1990). The razorback sucker is also known to complete its entire life cycle within lentic habitat types (Albrecht *et al.* 2010) and likely did so historically within the off-channel, backwater, and floodplain habitats described above. Assuming appropriate levels of habitat complexity, cover, predation/competition, razorback suckers seem to be relatively plastic in their habitat selection (Albrecht *et al*. 2010).

In lotic settings, larval razorback suckers use low velocity backwater and in-channel slackwater-type habitats (Tyus 1987, Muth *et al*. 2000).

In lotic systems, adult razorback suckers use pools and slow eddies from November through April (Ryden 2000). As flows rise in the spring, razorback suckers tend to use eddies along the inside of large river bends; displaying a strong affinity for mid-channel cobble riffles and run/riffles, as well as shoreline cobble-shoal-run type habitats (Ryden 2000). Few adult razorback sucker utilize swift, whitewater habitats (*e.g*., Blackrocks and Westwater canyons in the Upper Basin), but they can move through these areas (USFWS 2018c).

In lentic systems, adult razorback suckers use a wide variety of habitats, including inundated vegetation, shorelines, and substrates ranging from silt and sand to gravel and cobble.

Threats

The range and abundance of razorback suckers have significantly decreased due to water manipulation, habitat degradation, and the introduction of warm water non-native species. Construction of dams, reservoirs, and diversions destroyed, altered, and fragmented habitats razorback sucker habitats. Channel modifications reduced habitat diversity, and degradation of riparian and upland areas altered stream morphology and hydrology. The spread of warm water non-native predacious and competitive species within degraded habitat has substantially reduced the ability of adult and juvenile razorback suckers to persist. Razorback suckers can have large spawning events each year which may produce viable young. However, in most locations the eggs and larvae are consumed by warm water non-native fish species (Minckley 1991; Ehlo *et al.* 2017). The population trend range-wide follows the above pattern after this loss in young age-classes by a continued decrease in wild populations due to a lack of sufficient recruitment coupled with loss of older individuals due to natural aging processes. Fluctuating flows, such as those from load following at a dam during spawning season, may cause eggs to be dried where waters recede (McCall *et al*. 2017).

Distribution and Abundance

Razorback suckers are endemic to the Colorado River Basin, which encompasses parts of seven western states including Arizona, California, Colorado, Nevada, New Mexico, Utah and Wyoming as well as parts of Sonora and Baja California, Mexico. The Upper and Lower basins are split at Lees Ferry, Arizona, which is downstream from Glen Canyon Dam. Glen Canyon Dam provides physical separation between the Upper and Lower basins. Razorback suckers were widespread and common throughout the larger rivers of the entire basin (Minckley *et al*. 1991) with particularly high razorback sucker abundance in the Lower Basin near Yuma, Arizona (Gilbert and Scofield 1898). Razorback suckers are thought to have been uncommon in turbulent, canyon-bound reaches, with robust populations typically being found in calm, flatwater river reaches (Tyus 1987, Lanigan and Tyus 1989, Bestgen 1990). Historical populations were affected by the construction of multiple in-stream impoundments in the early-to-mid 1900s, which changed riverine conditions. Razorback suckers have persisted in some resulting reservoirs but have been extirpated from others.

Razorback sucker adults are present and spawning within the Colorado River Basin but have patchy distributions. Species presence is likely due to the species' ability to utilize both lotic (rapidly moving fresh water like a river) and lentic (still, fresh water like a reservoir or lake) environments (USFWS 2018c). Most populations in the Upper Basin are maintained by stocking,

and in the Lower Basin, except for Lake Mead, razorback sucker populations are also maintained through stocking, including populations in Lakes Mohave and Havasu (Marsh *et al*. 2015). Four populations are currently present in the Upper Basin, including in the Green, Colorado and San Juan subbasins and Lake Powell. Lower Basin populations currently occur in Lake Mead (and the Colorado River upstream of Lake Mead), Lake Mohave, the Colorado River between Davis and Parker dams (Lake Havasu), and the Colorado River below Parker Dam (USFWS 2018c). The stocking efforts for these populations rely on the captive broodstocks in the Upper and Lower basins, and the capture of wild-born larvae from Lake Mead and Lake Mohave to provide sub-adult fish for stocking programs.

The number of razorback suckers in the Colorado River system is only a fraction of historical populations, and groups or populations of fish are primarily maintained by stocking, except for the Lake Mead population (Albrecht *et al.* 2010, 2017; Marsh *et al*. 2015; Pennock *et al*. 2023).Recruitment has been occurring since the 1970s, sustaining the small population remaining in Lake Mead (Albrecht *et al*. 2010, USFWS 2012, Mohn *et al*. 2015); rangewide, however, recruitment is rare or nonexistent in other populations (Marsh *et al*. 2015).

Critical Habitat

FWS designated 1,725 mi (2,776 km) of razorback sucker critical habitat in the Colorado River Basin (59 FR 13374). This includes 944 mi (1,519 km) in the Upper Basin and 780 mi (1,255 km) in the Lower Basin.

FWS designated critical habitat for the four big river fishes (Colorado Pikeminnow, humpback chub, bonytail chub, and razorback sucker) concurrently in 1994, and the PBFs were defined for the four species as a group (59 FR 13374). However, the PBFs vary somewhat for each species on the ground, particularly regarding physical habitat, because each of the four species has different habitat preferences. The biological support document (Maddux *et al*. 1993) discusses in depth how each designated reach met the PBFs. The PBFs for the razorback sucker are:

- Water: This includes a quantity of water of sufficient quality (*i.e.*, temperature, dissolved oxygen, lack of contamination, nutrients, turbidity, *etc*.) that is delivered to a specific location in accordance with a hydrological regime that is required for specific life stages.
- Physical habitat: This includes areas of the Colorado River system that are inhabited by razorback suckers or potentially habitable for use in spawning, nursery, feeding, rearing, or corridors between these areas. In addition to river channels, these areas also include bottomlands, side channels, secondary channels, oxbows, backwaters, and other areas in the 100-year floodplain, which, when inundated, provide spawning, nursery, feeding, and rearing habitats.
- Biological environment: Food supply, predation, and competition are important elements of the biological environment and are considered components of this constituent element. Food supply is a function of nutrient supply, productivity, and availability to each life stage of the razorback sucker. Predation, although considered a normal component of this environment, may be out of balance due to introduced fish species in some areas. This may also be true of competition, particularly from non-native fish species.

Critical habitat was designated in 15 river reaches in the historical range of the razorback sucker and includes portions of the Colorado, Duchesne, Green, Gunnison, San Juan, White, and Yampa rivers in the upper basin, and the Colorado, Gila, Salt, and Verde rivers in the lower basin (59 FR 13374).

Previous Consultations

A list of consultations affecting this species is available on the Environmental Conservation Online System web platform.

ENVIRONMENTAL BASELINE

Under 50 CFR §402.02, the environmental baseline is "the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area; the anticipated impacts of all proposed Federal projects in the action that have already undergone formal or early section 7 consultation; and the impact of State or private actions which are contemporaneous with the consultation in process. The impacts on listed species or designated critical habitat from agency activities or existing Federal agency facilities that are not within the agency's discretion to modify are part of the environmental baseline."

The action area for this proposed federal action is the Upper Colorado River from the full pool of Lake Powell at 3,700 ft elevation and the Colorado River corridor from Glen Canyon Dam downstream to the Colorado River Inflow in Lake Mead. This area includes Lake Powell, Glen Canyon Dam, the river downstream to Lake Mead and the lower 0.25 mi (0.4 km) of the LCR. More specifically, the scope primarily encompasses portions of the Colorado River Ecosystem, which includes the Colorado River mainstream corridor and interacting resources associated with riparian and terrace zones, located primarily from the forebay of Glen Canyon Dam to the western boundary of Grand Canyon National Park. Portions of Glen Canyon National Recreational Area, Grand Canyon National Park, and Lake Mead National Recreational Area are included within this area.

The Colorado River Ecosystem is complex and formed in a sediment-laden, seasonally flooded environment and virtually all the resources are associated with or dependent upon water and sediment. The construction and operation of Glen Canyon Dam altered the natural dynamics of the Colorado River through the collection and storage of water for beneficial purposes in a process which traps sediment and associated nutrients that previously traveled down the Colorado River. The regulated releases from Glen Canyon Dam and Lake Powell have resulted in an altered aquatic and terrestrial ecosystem compared to that which existed before Glen Canyon Dam, and this environment is what defines the environmental baseline for this biological opinion.

The primary function of Glen Canyon Dam (and Lake Powell) is water storage and release to meet a multitude of objectives, including hydropower objectives. The amount of water and its pattern of release directly or indirectly affect the physical and biological resources within the Colorado River Ecosystem and establish the environmental baseline that the humpback chub and

razorback sucker inhabit. Water releases from Glen Canyon Dam fluctuate on a daily and hourly basis to maximize the value of generated power by providing peaking power during high-demand periods. More power is produced by releasing more water through the dam's generators. The Proposed Action limits actual daily fluctuations, although daily releases may vary between 5,000 and 31,500 cfs. These constrained fluctuations result in a downstream "fluctuation zone" between low and high river stages (*i.e*., the water level associated with a given flow) that is inundated and exposed daily.

Glen Canyon Dam also affects downstream water temperature and clarity. Historically, the Colorado River and its larger tributaries were characterized by heavy sediment loads, variable water temperatures, large seasonal flow fluctuations, extreme turbulence, and a wide range of dissolved solids concentrations. Glen Canyon Dam has altered these characteristics in the Colorado River between Glen Canyon Dam and Lake Mead. Before the dam, water temperature varied on a seasonal basis from highs around 80°F (27°) to lows near freezing. The regulated water releases from Glen Canyon Dam and Lake Powell have resulted in an altered aquatic and terrestrial ecosystem compared to that which existed before Glen Canyon Dam. In the latter part of the last century this resulted in cold, clear water releases from the dam, but climate change is resulting in reduced snowpack in the Upper Basin, which translates into less water flowing into Lake Powell and much warmer releases into the action area below Glen Canyon Dam. Lake Powell traps sediment that historically was transported downstream. The dam releases clear water, and the river becomes muddy when downstream tributaries contribute sediment, as during summer monsoon storms.

In the past, cold, clear water released from Glen Canyon Dam supported an important rainbow trout (*Oncorhynchus mykiss*) fishery in the Glen Canyon reach of the Colorado River. Predation by rainbow and brown trout (*Salmo trutta*) at the LCR confluence was identified as an additional fatality source affecting humpback chub survival, reproduction, and recruitment from the 1990's into the 2010's (Valdez and Ryel 1995, Marsh and Douglas 1997, Yard *et al*. 2011). Piscivory by brown trout was higher than for rainbow trout in the Grand Canyon (Yard *et al.* 2011, Whiting *et al*. 2014), but at the time, rainbow trout were much more abundant in the Colorado River and thus were thought to adversely affect humpback chub at a similar magnitude (Yard *et al*. 2011). In the past, cold(er) water down to the confluence with the LCR allowed rainbow trout to predate on emergent fry, young-of-year, and juvenile humpback chub; however, rainbow trout are no longer a threat to humpback chub recruitment due to the reduced habitat in the action area. Declining Lake Powell elevations that release warmer water are negatively affecting the historically important rainbow trout fishery. Rainbow trout are cold water fish that do best in water temperatures between 50–60°F (10–15°C). The current water temperature at Lees Ferry is 68.5°F (20.7°C), which is not conducive to rainbow trout survival.

The Basin experienced three of the lowest consecutive years of inflow on record in 2020 through 2022, with 2021 among one of the lowest inflow years on record. During this time, the combined storage of Lake Powell and Lake Mead declined from about 50% to 25% of total live capacity. Due to an above average snowpack in winter 2023, live capacity increased to approximately 35%. In 2024 and 2025, unregulated inflows to Lake Powell were 7.98 and 4.69 maf, respectively (83% and 49% of average water year inflow, respectively), and WY 2026 is projected to be around 3.4 maf (35% of average water year inflow), the second lowest year on record. As of June 2026, live storage at Lake Powell is at 24%.

The combination of drought and dam operations has affected aquatic resources in several ways. Beginning in the mid-2000s, warming water released from Glen Canyon Dam allowed for significant growth of the humpback chub population in the western Grand Canyon; over about 20 years, a relatively small population of humpback chub increased to perhaps 100,000 individuals in 2025 (Dzul *et al*. 2026). These warmer releases also altered river habitat such that non-native invasive fish species could begin to reproduce, and, in 2015, green sunfish (*Lepomis cyanellus*), a highly piscivorous warm water non-native fish, were detected spawning below the dam for the first time. Despite control efforts (mechanical removal and chemical treatment of hot spots), green sunfish spread throughout the Glen Canyon reach and continue to move downstream.

Smallmouth bass, a more effective piscivore than green sunfish, have negatively affected native fish populations, particularly chub populations in the southwestern United States. Small numbers of adult smallmouth bass were detected in the Colorado River between Glen Canyon Dam and Lake Mead prior to 2022. Lowering lake levels allowed for more smallmouth bass to move through the dam into the river below, and, in 2023, the number of smallmouth bass in Glen Canyon increased with detections of the first river-spawned smallmouth bass (Eppehimer *et al*. 2025). The number of captured bass increased as a concerted effort to detect and remove smallmouth bass began, and, in 2024, Reclamation initiated water releases designed to reduce water temperatures to prevent smallmouth bass from spawning in the river. We discuss this further below.

Humpback Chub and Critical Habitat

Status of the Species and Critical Habitat within the Action Area

The humpback chub is found within the action area in small numbers in the Lake Powell footprint, as two self-sustaining populations and nine aggregations in the Colorado River downstream of Glen Canyon Dam. Additionally, there are individual or groups of humpback chub that can occur throughout the action area.

Status of the Humpback Chub and Critical Habitat Above Glen Canyon Dam

The humpback chub is primarily a riverine species; therefore, its presence is rare in Lake Powell. However, the humpback chub does occur in small numbers in the Colorado River inflow, but none have been reported from the San Juan River inflow (DOI 2026a). When Lake Powell was at or near high elevation (1980–1985), a humpback chub population in Cataract Canyon extended downstream as far as Imperial Canyon (RM 200) (Persons *et al*. 1982. Valdez 1990, Valdez *et al*. 1982), which was then the river/lake interface. As the lake elevation dropped (3,700 ft in 1986 to 3,670 ft in 2000), historical riverine habitat was increasingly exposed downstream of Imperial Canyon, and small numbers of young-of-year and juvenile *Gila* spp. were reported but not confirmed as humpback chub (Valdez and Cowdell 1994). Small numbers of *Gila* spp. larvae, possibly transported downstream from the Cataract Canyon population, were found in 2000 to 2020 from Imperial Canyon to Trachyte Canyon (RM 162) (Albrecht *et al*. 2017, Brandenburg 2015, Mueller *et al.* 2001). In 2021, Ahrens (2022) captured four humpback chub in the exposed riverine habitat of lower Cataract Canyon downstream of the Big Drops and within the action area. The Colorado River downstream of Imperial Canyon is not monitored annually for humpback chub, and the downstream extension of the Cataract Canyon population is not

currently known with certainty.

Critical habitat for the humpback chub above Glen Canyon Dam includes the Colorado River within Cataract Canyon, from Brown Betty Rapid (RM 212, distance upstream from Lees Ferry) to Imperial Canyon (RM 200). Imperial Canyon is at an elevation of 3,680 ft and is within the highest elevation of Lake Powell at 3,700 ft at RM 201.5. The lowest 1.5 mi (2.4 km) for this reach of critical habitat lies within the full pool elevation of Lake Powell, which is within the action area. Critical habitat for humpback chub is not designated in the San Juan River or anywhere else in the Lake Powell footprint.

The current condition of critical habitat in this portion of the action area is likely low due to its intermittent connection with Lake Powell. When Lake Powell elevations are high, area does not provide the physical habitat PBF (*e.g*., suitable spawning, nursery, feeding habitat) or the biological environment PBF (*e.g*., out of balance predation and competition). When Lake Powell elevations are lower it may allow for decreased movement of non-native fish from the lake.

Status of the Humpback Chub and Critical Habitat Below Glen Canyon Dam

Below Glen Canyon Dam, there are two self-sustaining populations and nine known aggregations (consistent and disjunct localized groups) of humpback chub (Rinker *et al*. 2025, Dzul *et al*. 2026). The LCR population of humpback chub has been regularly monitored since the early 1980s. The number of adults in the LCR has varied from about 4,000 to 11,000 adults (1989–2008) (USFWS 2018a) and most recently is stable at about 11,000 adults (Yackulic *et al*. 2014). Recently, a large humpback chub population has established in western Grand Canyon, from Havasu Rapid (RM 157) to below Pearce Ferry (RM 281) (Rogowski *et al.* 2018; Van Haverbeke *et al*. 2017, 2023). The western Grand Canyon population had a median adult population abundance of 70,000 (40,000–200,000; 95% credible interval) in 2024 (Dzul *et al.* 2026). The total number of adult humpback chub in the aggregations is about 225, not including the adults found in the LCR or the western Grand Canyon (USFWS 2018a). The most upstream aggregation is at RM 30 (30-Mile), then the LCR, with aggregations downstream to Pumpkin Spring. Based upon this information, there are approximately 81,225 adult humpback chub below Glen Canyon Dam in the action area (DOI 2026a).

The western Grand Canyon and LCR humpback chub populations have limited connectivity (Fonken *et al*. 2023). However, recent genetic analyses found that humpback chub in Grand Canyon constitute a single genetic population (Dzul *et al*. 2025, Marshall 2026). Therefore, while movement data indicate limited upstream exchange, the western Grand Canyon population remains genetically connected to the LCR population and the eight aggregations within Grand Canyon.

Agency biologists have translocated humpback chub to three tributaries in the Grand Canyon. Biologists translocated juvenile humpback chub from the LCR to Shinumo Creek from 2009 through 2013, but stocking was suspended following a fire and subsequent flood/debris flow that killed most of the fish. Small numbers of humpback chub are still detected in the aggregation adjacent to Shinumo Creek (Van Haverbeke *et al*. 2022, 2023). Biologists translocated juvenile humpback chub to Havasu Creek annually from 2011 through 2016, and surveys have observed evidence of reproduction since 2012 (Spurgeon *et al*. 2015). The estimated abundance in Havasu

Creek in 2022 was 145 adults (95% confidence interval: 138–170), indicating a stable population (NPS 2022). The NPS and FWS also translocated humpback chub to Bright Angel Creek in 2018, 2020, and 2022. The NPS estimated low initial survival estimates (3–11%), but additional translocations are planned for Bright Angel Creek (NPS 2022). In summary, humpback chub translocated into Shinumo Creek were extirpated by local debris flows from a fire-scarred drainage, and humpback chub translocated into Havasu Creek and Bright Angel Creek persist with evidence of reproduction in the former.

Humpback chub designated critical habitat downstream of Glen Canyon Dam extends along about 174 mi (280 km) of the Colorado River in Grand Canyon from Nautiloid Canyon (RM 35, distance downstream from Lees Ferry) to Granite Park (RM 209). Critical habitat for humpback chub in the action area also includes approximately 0.25 mi (0.4 km) of the LCR critical habitat reach, which is the area of the LCR affected by mainstem flow.

The total critical habitat in the LCR from extends from RM 8 (8 mi [13 km] upstream of the confluence with the Colorado River) downstream to the confluence with the Colorado River. Water quantity, quality, and associated fish habitat in the LCR are affected primarily by perennial springs in the lower reaches and seasonally by runoff from tributaries in the upper reaches. The areas typically used for spawning (*i.e.*, complex rocky shorelines) are likely too far from the confluence to be affected by physical changes to the Colorado River. However, if the Colorado River became a source of warm water non-native fish (*e.g*., smallmouth bass), effects on the biological environment PBF could extend beyond 0.25 mi (0.4 km) within the action area.

The current condition of critical habitat in the LCR is probably like historical conditions in many ways. All the PBFs are provided for in this reach of humpback chub critical habitat, and this segment supports most of the humpback chub in Grand Canyon.

Since 1964, Glen Canyon Dam has changed how the Colorado River flows through Marble and Grand canyons. The construction and operation of Glen Canyon Dam substantially altered habitat in Marble and Grand canyons compared to historical conditions (see discussion in USFWS 2011a); however, components of the PBFs of critical habitat are present. The dam's presence and its management are the main influences on the function of water, physical habitat, and biological environment PBFs in this section of the river. Operation of the dam alters the water quality and quantity PBF by altering water temperatures and flow regimes. Since 1996, Reclamation has adaptively managed water releases from Glen Canyon Dam to improve water quality and quantity for humpback chub in the Colorado River through Grand Canyon (DOI 1996). The physical PBF for spawning (*e.g*., Dzul *et al*. 2026), nursery, feeding (*e.g.*, Hoffnagle *et al*. 2006), and movement corridors (*e.g*., Valdez and Ryel 1995, Paukert *et al*. 2006) is present within this critical habitat reach based upon the evidence of recruitment into the western Grand Canyon population and the aggregations. Dam discharge and river flow regimes can both destroy and build shoreline rearing habitat, thus affecting the physical habitat PBF (Converse *et al*. 1998). Fluctuating flows can destabilize backwater habitats and may negatively affect aquatic macroinvertebrate production (Kennedy *et al*. 2016), which affects the biological environment PBF. Feeding areas are available to all life stages, especially for adult fish as indicated by adult humpback chub condition factors in the mainstem compared to those in the LCR (Hoffnagle *et al*. 2006), although feeding areas in the mainstem may be limiting for juvenile humpback chub because of fluctuations on nearshore habitats. Importantly, this critical habitat reach, as of now,

currently does not contain an established population of non-native warm water predacious species that is degrading the biological environment PBF through unsustainable levels of predation and competition; however, there is potential for this to change due to the entrainment of smallmouth bass into critical habitat. Currently though, many components of the PBFs are functional as demonstrated by the persistence of mainstem aggregations of humpback chub and the thriving western Grand Canyon population. This critical habitat reach provides an important role in support of the Grand Canyon humpback chub population.

Factors Affecting Species and Critical Habitat within the Action Area

Factors Affecting Humpback Chub and Critical Habitat Above Glen Canyon Dam

Factors affecting the distribution and abundance of humpback chub in Lake Powell include the changes in elevation of Lake Powell. The elevation of Lake Powell affects the length of riverine habitat in the Colorado River inflow and the amount of available habitat for the downstream extension of the Cataract Canyon population, although only small numbers of humpback chub have been reported from this exposed river channel.

Factors Affecting Humpback Chub and Critical Habitat Below Glen Canyon Dam

The primary factors affecting humpback chub and critical habitat within the action area are habitat alterations associated with dams and reservoirs that have modified water temperature, and the introduction of warm water non-native fishes, which act as competitors and/or predators of the humpback chub (USFWS 2018a).

Smallmouth bass were introduced to the Upper Basin in the late 1960s. Since 2003, fish surveys have periodically captured individual smallmouth bass in Glen Canyon, immediately downstream from Glen Canyon Dam. It was assumed that these smallmouth bass were entrained through Glen Canyon Dam and that unfavorable cold-water conditions below the dam inhibited their ability to establish. In July 2022, a single juvenile smallmouth bass was captured in Glen Canyon at the 12-mile slough. The capture of the smallmouth bass and the establishment of green sunfish (circa 2015) coincided with the warmest Glen Canyon Dam release temperatures ever recorded (70°F [21°C]). This temperature increase represented an 11.7°F (6.5°C) increase from the maximum release temperatures averaged over the previous 10 years. The warmer water temperatures driven by record low Lake Powell elevations enabled smallmouth bass to persist, grow, and spawn below Glen Canyon Dam.

Rapid response monitoring efforts in 2022 and 2023 found 362 individual smallmouth bass between Glen Canyon Dam and Lees Ferry, and 1,113 smallmouth bass between the dam and RM 16. Surveys detected the highest densities of smallmouth bass in the first 15 mi (24 km) of the Lees Ferry reach. Between July 12, 2022, and July 6, 2026, surveys detected 33 adult (≥200 mm) smallmouth bass from just below Glen Canyon Dam (RM -15.73) to RM -1.49. Adult smallmouth bass are capable of reproduction. This significant increase in smallmouth bass detections raised concerns about their potential to establish within Grand Canyon. The detrimental effects of smallmouth bass on native fish are well-established (Haines and Modde 2007, Loppnow *et al*. 2013, Schmidt *et al*. 2024, Bruckerhoff *et al*. 2025, Eppehimer *et al*. 2025, Pine *et al*. 2025, Bestgen *et al*. 2026). Smallmouth bass out compete and predate upon native fish

and the potential for this warm water non-native fish to substantially reduce and/or remove the largest federally protected humpback chub population(s), which resides in the action area, is significant (Dibble *et al*. 2021, Bruckerhoff *et al*. 2022, Eppehimer and Yackulic 2024, Eppehimer *et al*. 2025).

To combat the invasion of smallmouth bass downstream from Glen Canyon Dam, Reclamation implemented the "Cool Mix" flow alternative in 2024 and 2025 as part of the Glen Canyon Dam LTEMP Supplemental Environmental Impact Statement (SEIS; DOI 2024). The Cool Mix flow releases cold water through bypass tubes (River Outlet Works, bypassing the dam generators) to mix with warmer penstock flows when daily average river temperatures exceeded 60°F (15.5°C) for three days. These flows aimed to cool the river to 60°F (15.5°C) to inhibit smallmouth bass spawning by making the water too cold to trigger spawning. Monitoring indicates that Cool Mix flows conducted in 2024 and 2025 were likely successful at preventing smallmouth bass reproduction below Glen Canyon Dam. Currently, Cool Mix is the only conservation measure proven to limit smallmouth bass reproduction, reduce growth of entrained fish and reduce future survival and recruitment, and therefore spread of the species throughout the Colorado River below Glen Canyon Dam. Reclamation did not conduct Cool Mix flows in 2026. However, Reclamation is funding response efforts by the NPS, AZGFD, FWS, and GCMRC to locate and remove smallmouth bass below Glen Canyon Dam. Agency biologists have and continue to conduct electrofishing as well as other methods, with an emphasis on the area below the dam downstream to Badger Rapid (RM 8) (Shollenberger *et al*. 2025). All fish monitoring trips are actively looking for smallmouth bass and green sunfish even if the trip has a different purpose. Smallmouth bass have yet to establish below Glen Canyon Dam. DOI defines an 'established species' as a species with a self-sustaining, reproducing population (DOI 2016c). We do not consider smallmouth bass established below Glen Canyon Dam because even if they have reproduced, smallmouth bass are not currently self-sustaining.

Downstream of Glen Canyon Dam, the humpback chub is affected by water releases from the dam and subsequent elevation and changes in flow of the Colorado River, the temperature of releases and downstream warming or cooling, tributary inflows that locally affect temperature and turbidity, and non-native fish that impose competition and predation pressures. For the LCR population, water levels and changes in flow and temperature affect young humpback chub moving into the mainstem by destabilizing their shoreline habitat and affecting their survival. Flow and temperature also affect the physiological condition of juveniles, subadults, and adults by affecting their food supplies, metabolic rates, and seasonal spawning readiness. The greatest threat to humpback chub below Glen Canyon Dam is the potential for smallmouth bass to establish, which would adversely affect humpback chub survival in the mainstem and subsequent recruitment in the LCR (Van Haverbeke *et al*. 2013, Yackulic *et al*. 2014). Humpback chub prefer water temperatures that range from 64–72 °F (18–22 °C) (USFWS 2018a). However, high water temperatures (>61 °F [16 °C]) can also benefit warm water predators, such as smallmouth bass, which negatively affect humpback chub through predation and competition.

The increase in the western Grand Canyon population of humpback chub was probably made possible by the declining elevation of Lake Mead, the change from lake to riverine habitat in the Colorado River inflow (Boyer *et al*. 2024, Fonken *et al*. 2023), and warmer releases from Glen Canyon Dam (Van Haverbeke *et al*. 2017). The Pearce Ferry Rapid has evolved into a partial barrier to upstream movement of non-native predacious fish from Lake Mead into western Grand

Canyon that has likely reduced predation and competition on the humpback chub (Rogowski *et al*. 2025). The elevation of Lake Mead must be below 1,090 ft for the Pearce Ferry Rapid to persist; therefore, although declining water is a concern for many reasons, the lower Lake Mead levels are beneficial to humpback chub.

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

In summary, although warming waters and the Pearce Ferry barrier to non-native fish movement upstream have resulted in increases in the humpback chub population, the entire system is now at risk from invasion of smallmouth bass. The lower Lake Powell elevations increase the potential for entrainment, potentially creating a regular source of smallmouth bass in the Colorado River below Glen Canyon Dam. Further, the warmer temperatures create habitat conditions that support spawning, survival, growth and recruitment of smallmouth bass that was previously inhibited by the low water temperatures leaving the dam. These conditions result in a situation where smallmouth bass have the potential to completely change the trajectory of humpback chub recovery and threaten the most robust population of humpback chub through the species range.

Razorback Sucker and Critical Habitat

Status of the Species and Critical Habitat within the Action Area

Status of the Razorback Sucker and Critical Habitat Above Glen Canyon Dam

Within the action area, the razorback sucker is found in the Colorado River and San Juan River inflows of Lake Powell. Within these areas, razorback suckers use both the inundated lake and the exposed riverine habitat. The low elevation of Lake Powell over the last several years has created more riverine habitat and aggregations of ripe and gravid adult razorback sucker, as well as larvae, have been found in both inflows, indicating that spawning is taking place within the action area (Francis *et al*. 2017).

In the San Juan River inflow, razorback suckers use the 30 mi (48 km) reach of the river from the Piute Farms waterfall downstream to Neskahai Canyon at low Lake Powell elevations (Francis *et al.* 2017, Schleicher *et al*. 2024). Ripe and gravid razorback suckers aggregate near these sites, and larvae have been found in their proximity, indicating successful reproduction. In 2024, when the lake elevation was most stable, the Neskahai Canyon location had increased amounts of lower-sloped, exposed clean cobble, and relatively vegetation-free habitat that razorback suckers seem to prefer for spawning, compared to downstream areas (Schleicher 2025). The Piute Farms waterfall completely blocks upstream fish movement into the San Juan River and is located at about RM 230 (230 mi [370 km] downstream of Navajo Dam). It was formed in 2001, is about 30 ft (9 m) tall, and forms when the Lake Powell elevation drops below about 3,660 ft (Cathcart

et al. 2018, USFWS 2022).

Razorback suckers are not caught as frequently in the Colorado River inflow as they are in the San Juan River inflow, possibly because the species is stocked near the latter inflow. From 2014 to 2024, surveys reported 53 larval razorback sucker from the Colorado River inflow (DOI 2026a). In 2021, exploratory sampling downstream of Cataract Canyon, in the Lake Powell inflow, did not detect razorback sucker, but the habitat of the areas formerly inundated by Lake Powell appeared suitable for the species (Ahrens 2021). All spawning activity of razorback suckers in the Colorado River inflow was downstream of critical habitat, but data does indicate that razorback suckers spawn at or near the river/lake interface in both inflows, and spawning locations may vary with lake elevation.

The action area above Glen Canyon Dam includes the full pool of Lake Powell at an elevation of 3,700 ft. Within this area, critical habitat in the Colorado River inflow extends 33.5 mi (54 km) from above Imperial Canyon (RM 201.5) downstream to North Wash (RM 168). In the San Juan River inflow, razorback sucker critical habitat includes the San Juan River and its 100-year floodplain for approximately 39 mi (63 km) from the Neskahai Canyon (RM −30) upstream to Clay Hills (RM 2.9).

Critical habitat in the San Juan River faces multiple challenges (USFWS 2022). Because of the on-going drought, spring peak flows do not occur at the recommended frequency and magnitude and this likely impedes the recruitment of wild-spawned individuals (USFWS 2022). While baseflows are typically within recommended ranges, barriers limit passage and numerous diversions pose entrainment risk, especially for small fish.

The fish communities in both the Colorado River and San Juan inflows consist of a multitude of non-native fish that adversely affect the biological environment PBF of critical habitat (USFWS 2018c).

Status of the Razorback Sucker and Critical Habitat Below Glen Canyon Dam

Razorback suckers are also found in the Colorado River through the lower half of the Grand Canyon and as a small reproducing population that extends from Lake Mead into the lower end of the action area upstream of Pearce Ferry. The number of razorback sucker larvae captured in the Colorado River between Glen Canyon Dam and Pearce Ferry Rapid ranged from 462 to 0 in 2014 through 2020 (DOI 2026a). Recent surveys and monitoring of the area suggest a small increase in the number of suckers moving upstream, and the collection of larvae indicates that successful spawning is taking place (Rogers *et al*. 2023).

More recently FWS and NPS have stocked tagged razorback suckers into both Havasu Creek (n=1,273) and the LCR (n=1,481) (USFWS 2026). Biologists stocked razorback suckers in Big Canyon, a tributary to the LCR approximately 6.8 mi [11 km] upstream, and in the mainstem LCR above Blue Springs, approximately 17–21 mi (28–33 km) upstream from the confluence with the Colorado River. In Havasu Creek, biologists stocked razorback suckers in 2023 and 2025. Nine razorback suckers from the 2023 Havasu Creek stocking were captured during sampling and 5 others were detected on antennas in the mainstem Colorado River (1 at RM 213.79, near Pumpkin Springs; and 4 at RM 181.64, just below Lava Fall Rapid). Biologists have

yet to detect or capture razorbacks from the 2025 Havasu Creek stocking. The 2024 LCR stocked razorback suckers have the most detections and captures (n=106) with most occurring in the LCR and the confluence of the LCR and Colorado River (USFWS 2026).

The Pearce Ferry Rapid is on the Colorado River inflow to Lake Mead and is a partial barrier to fish movement (Rogowski *et al*. 2025). It began forming as a rapid in 2010 and is a long twisting rapid with intermittent steep drops and high velocity.

Critical habitat within the action area includes 281 mi (452 km) Colorado River and its 100-year floodplain from the confluence of the Paria River (approximately 15 mi [24 km] below Glen Canyon Dam) downstream to Pearce Ferry (59 FR 13374).

Factors Affecting Species and Critical Habitat within the Action Area

Factors Affecting the Razorback Sucker and Critical Habitat Above Glen Canyon Dam

The San Juan River Basin Recovery Implementation Program (SJRIP) and the Upper Colorado River Fish Endangered Recovery Program (UCREFRP) are working to recover the razorback sucker (as well as the other big river fishes). The SJRIP is specific to the San Juan River, including the San Juan River arm of Lake Powell. The program was established in 1992 and is funded through 2027. All recovery efforts for razorback suckers are outlined each year through this program's Long-Range Plan and include actions to improve habitat, stocking, and monitoring. UCREFRP is a partnership of local, state and federal agencies, water and power interests and environmental groups. The program is authorized through 2027. Recovery efforts for razorback suckers are implemented each year through annual budgeting and work plan process. Specific activities are defined in the Recovery Implementation Program/Recovery Action Plan (RIP/RAP), including augmentation, flow and habitat management, non-native fish control and monitoring consistent with the razorback sucker Recovery Plan (USFWS 2002b).

Physical factors that affect the distribution and abundance of the razorback sucker in Lake Powell are principally related to lake elevation. At high lake elevation, there is little riverine habitat within the reservoir's footprint, and the Piute Farms waterfall becomes inundated, allowing fish to move unimpeded from Lake Powell upstream into the San Juan River. This fish movement provides a natural connection for native fish, including razorback sucker, inhabiting the lake and the river, but it also allows non-native predatory and competitive fish to move from the reservoir upstream into native fish habitat in the San Juan River.

At low lake elevations, the river channels of both the Colorado and San Juan Rivers are increasingly exposed, providing more riverine habitat that benefits certain native fish species. At low lake elevations, the Piute Farms waterfall becomes a barrier to upstream fish movement, preventing native fish, including razorback suckers, from moving from the reservoir upstream into historical habitat. The waterfall prevents movement of non-native fish into the San Juan River and reduces predation and competition on native fish.

In the San Juan River, where floodplain habitats are also absent, razorback sucker larvae are found in low-velocity habitats, such as backwaters, and flooded wash mouths (USFWS 2018c).

Factors Affecting the Razorback Sucker and Critical Habitat Below Glen Canyon Dam

The decline of the razorback sucker in the Grand Canyon and throughout its range has been attributed primarily to habitat modification from dam construction, leading to cold-water releases, habitat loss, migration impediments, streamflow regulation, and predation by non-native fish species (DOI 2026a). In the Colorado River from Glen Canyon Dam to Pearce Ferry, the razorback sucker is limited by cool water temperature, a paucity of shallow gravel/cobble spawning sites, and the lack of floodplain nursery habitat (Valdez and Nelson 2004, USFWS 2018c).

The Colorado River has been warmer over the last few years due to lower Lake Powell elevations, which is beneficial for razorback suckers and the PBFs of critical habitat. Additionally, the formation of Pearce Ferry, which created a barrier to upstream movement of fish from Lake Mead, has changed the community composition from one dominated by non-native species to one dominated by native species (Kegerries *et al*. 2015). The Pearce Ferry barrier, combined with an extended river channel and warmer water temperatures, most likely has supported the expansion of razorback sucker and other native fishes into the western Grand Canyon.

EFFECTS OF THE ACTION

Effects of the action refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. Indirect effects are those that are caused by the proposed action and are later in time but still are reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR §402.02 [2018]).

Humpback Chub and Critical Habitat

Effects of the Action on the Species

As described above in the Environmental Baseline, humpback chub are unlikely to occur in the Colorado River inflow in Lake Powell. We anticipate that the expected low Lake Powell elevations over the life of this project will result in discountable effects on humpback chub above Glen Canyon Dam.

The Proposed Action is likely to have substantial adverse effects on humpback chub below Glen Canyon Dam. We expect that the following will occur:

1. Lake Powell elevations due to long-term drought and reduced flows from the Upper Basin will continue to increase river temperatures downstream of the Glen Canyon Dam. The low lake elevations will also result in increased entrainment of warm water non-

native species, such as smallmouth bass, through the dam. The warmer water in the Colorado River below the dam will provide habitat that will allow smallmouth bass (as well as other warm water non-native fish) to grow, reproduce, and establish in the action area below Glen Canyon Dam.

2. The daily operations of Glen Canyon Dam will alter shoreline habitat.

Lake Powell Elevations

The lower Lake Powell elevations that will occur with the Proposed Action may influence the establishment of smallmouth bass by providing spawning habitat immediately above Glen Canyon Dam, increase entrainment and survival of entrained fish, and provide suitable habitat downstream of Glen Canyon Dam. We discuss each of these effects below.

When Lake Powell elevation is low, the shoreline fish habitat that is created may increase smallmouth bass spawning habitat immediately above the dam. At lower Lake Powell elevations (<3,600 ft), the lake shoreline consists largely of vertical cliffs and rock falls that favor smallmouth bass. If smallmouth bass are spawning near the dam, this likely increases their ability to move downstream via entrainment. Although we can quantify the amount of time Lake Powell may be below 3,600 ft, we do not know how much spawning habitat is available or how smallmouth bass may be using these areas, but we think it is an important factor to consider. As part of the proposed action, Reclamation proposed three conservation measures to reduce entrainment. To the extent practicable, Reclamation plans to limit the use of Unit 1 (penstock) that draws water from an area where smallmouth bass may spawn. Additionally, Reclamation will consider a device to deter fish movement into the Glen Canyon Dam forebay and design and implement a study to evaluate fish entrainment through Glen Canyon Dam. Only the first measure is one Reclamation can immediately implement (use of Unit 1), but as more specifically addressed in the conservation measures section, Reclamation has committed to implementing the other measures, has staff committed to implementation of those measures, is pursuing adequate funding for completion of those measures, and has established completion dates for tasks to ensure these measures are implemented. FWS will work closely with Reclamation to ensure the conservation measures are implemented as described and on schedule, or we will re-initiate consultation.

Data provided by Reclamation indicates that the number of smallmouth bass entrained through Glen Canyon Dam will increase as the lake level decreases. Greater than 90% of the smallmouth bass population near the dam is found in the upper 60 ft (18 m) of the water column (Friesen 2024). Modeling indicates that if Lake Powell elevations are less than 3,565 ft, entrainment of fish in the reservoir will remain high as the dam draws from the higher, warmer layers of the water column favored by smallmouth bass (Eppehimer *et al*. 2025). The model predicts that reservoir starting elevations (starting with October 1, the first day of the WY) above 3,565 ft (35% of capacity) would significantly reduce the risk of entrainment of smallmouth bass and other undesirable non-native fish species due to intake of cooler hypolimnetic (deepest, densest layer) water largely absent of fish (Table 6). Additionally, smallmouth bass entrained at lower lake elevations have a higher survival rate than those entrained at higher lake elevations (Friesen 2024). Therefore, Lake Powell elevations below 3,540 ft not only allow for increased entrainment of smallmouth bass, but data also indicates a higher number of the entrained fish will survive.

Lake Powell elevation also affects water temperature, which affects thermal suitability for fish downstream of the dam. There are three key lake elevational ranges related to smallmouth bass: 3,490 to 3,540 ft (high entrainment, high survival), 3,540 to 3,565 ft (high entrainment, moderate survival), and above 3,565 ft (low entrainment, low survival). Lake Powell's elevation has remained above 3,565 ft for most of the time since 1964, except during its initial filling period and the recent drought conditions that have driven the reservoir to unprecedented lows resulting in recent increases of smallmouth bass entrainment (2021–2026). Eppehimer *et al*. (2025) developed a model to predict the number of fish successfully passing through Glen Canyon Dam at different lake elevations, and to link reservoir storage/operations, water temperatures, and smallmouth bass population dynamics to forecast population growth rates (λ, lambda) under different hydrologic and management scenarios. As we would anticipate based on smallmouth bass ecology, as lake elevations decrease and water temperatures increase, the likelihood of the smallmouth bass population growing, and likely establishing, downstream of the dam, increases.

Reclamation modeled future hydrologic traces under two scenarios using the driest 2- and 10-year average annual inflow values (DOI 2026a). Any scenario with less water than the lowest historical 2-year average will result in Lake Powell falling below 3,490 ft, which is outside the proposed action and will result in section 7 consultation under the Act. The modeled scenarios indicate that Lake Powell is likely to spend most of the coming decade (life of the project) at lake elevations that result in high smallmouth bass entrainment (below 3,565 ft elevation, 68% of years in Scenario 1, 57% of years in Scenario 2) and a significant proportion of years in the lowest elevational range (3,490–3,540 ft) (DOI 2026a). The model also found the following:

- Lake Powell elevations will be below 3,600 ft for most of the next 10 years.
- Both scenarios suggest that Lake Powell is likely to be below 3,565 ft in elevation, which Eppehimer *et al*. (2025) modeled could result in entrainment of 44 fish per year (Table 6).
- Approximately 40% of Scenario 1 years and 30% of Scenario 2 years have average annual elevations below 3,540 ft, which indicates high survival potential of entrained smallmouth bass.
- Smallmouth bass population growth will be lowest (λ average = 0.80) when Lake Powell elevation is above 3,565 ft, and highest (λ average = 1.41) when Lake Powell elevation is 3,490– 3,540 ft. Without intervention to remove smallmouth bass, smallmouth bass population below the dam when the lake is in this elevation range (3,490–3,540 ft) can be expected to grow (λ average = 1.41, median = 1.40), and this elevational range occurs more frequently in both scenarios (40% and 28% of years in Scenarios 1 and 2, respectively).

Low Lake Powell elevations increase the entrainment rate and survival of entrained individual fish, which results in a positive smallmouth bass population growth rate (Eppehimer *et al*. 2025). Eppehimer *et al*. (2025) found that if Lake Powell elevations stay above 3,570 ft 80% of the time this would significantly reduce the risk of smallmouth bass and other non-native species entrainment. At the time we are writing this biological opinion, Lake Powell elevation is 3,526 ft and it is likely to go closer to 3,490 ft, which is the minimum. Data provided by Reclamation indicates that the number of smallmouth bass entrained through Glen Canyon Dam will increase

as the lake level decreases. Greater than 90% of the smallmouth bass population near the dam is found in the upper 60 ft (18 m) of the water column (Friesen 2024). Modeling indicates that if Lake Powell elevations are less than 3,565 ft, entrainment of fish in the reservoir will remain high as the dam draws from the higher, warmer layers of the water column favored by smallmouth bass (Eppehimer *et al*. 2025). Smallmouth bass entrained at lower lake elevations have a higher survival rate than those entrained at higher lake elevations (Friesen 2024). Therefore, Lake Powell elevations below 3,540 ft not only allow for increased entrainment of smallmouth bass, but data also indicates a higher number of the entrained fish will survive.

Smallmouth bass entrained through Glen Canyon Dam can move downstream and may establish a self-sustaining population. If smallmouth bass are established in Grand Canyon, they have the potential to substantially adversely affect the currently thriving humpback chub population through competition and predation. Measurable negative effects on humpback chub may not occur for several years, particularly in the western Grand Canyon where smallmouth bass must move 200 mi (322 km) downstream to interact with that humpback chub populations. However, while the effects may not be immediate, if smallmouth bass become established, eradicating them may be an impossible feat. Using existing tools (*i.e*., chemical piscicides), agencies have only been able to successfully remove smallmouth bass from much smaller systems (*e.g*., Marks *et al*. 2009) and in most cases extirpation of smallmouth bass is unlikely and suppression will require multiple efforts in perpetuity (Loppnow *et al*. 2013). Thus, although effects on the population may lag in time, any effects from the action leading to establishment can be considered immediate due to the difficulty in eradicating smallmouth bass as their population numbers increase. Models developed for the Upper Colorado River have found that the minimum removal rate required to initiate a long-term reduction in smallmouth bass would need to exceed 60% of the population (Haines and Modde 2007, Schmidt *et al.* 2024). To date, smallmouth bass removal efforts in the Upper Basin have resulted in estimated exploitation rates of 21–38% (Lawry *et al*. 2025, Tuttle *et al*. 2025,).

Reclamation proposes to implement and study the implementation of several conservation measures to minimize the potential effects of entrained smallmouth bass and other non-native warm water species. These conservations measures will not replace the conservation measures in the LTEMP Biological Opinion (USFWS 2016a) (Table 5) that are ongoing. The intent of these conservation measures is to:

1) Reduce the number of smallmouth bass and other non-native warm water species that may be entrained through the dam via removal efforts in Lake Powell and deterrence barriers.
2) Reduce the number of smallmouth bass and other non-native warm water species present below Glen Canyon Dam via mechanical and chemical removal methods.
3) Conduct translocations to increase the distribution of humpback chub in the action area (*e.g*., within tributaries).
4) Monitor the status of both native and non-native fish populations to identify changes in populations and distributions.

These conservation measures, in conjunction with the ongoing LTEMP conservation measures, aim to address threats by identifying long-term tools, such as a temperature control device to inhibit smallmouth bass spawning below Glen Canyon Dam, and by developing new tools that

can be used to control non-native and invasive fishes. Smallmouth bass control is most effective when it targets eggs, larvae, and juveniles. Accordingly, stopping entrainment of fish through Glen Canyon Dam and then conducting actions that affect these more vulnerable life stages are likely to be most effective (Loppnow *et al*. 2013).

Warmer water releases from Glen Canyon Dam, in the absence of non-native fish, would be beneficial for humpback chub growth throughout the river. Humpback chub populations increase where water temperatures increase and non-natives are rare (Dibble *et al*. 2021). Unfortunately, currently, warm water releases and low Lake Powell elevations are not a benefit to the humpback chub population below Glen Canyon Dam unless ongoing and future conservation actions inhibit smallmouth bass establishment.

Daily Releases from Glen Canyon Dam

Releases from Lake Powell of <6,000 cfs could reduce available shoreline habitat along the Colorado River downstream of Glen Canyon Dam while also increasing shoreline temperatures, which in turn may elevate the metabolic rate and growth of humpback chub, potentially shortening the period during which small fish are vulnerable to predation. Although humpback chub can use the entire action area, there are two major self-sustaining populations in the action area: the LCR and western Grand Canyon. Juvenile humpback chub leave the LCR in large numbers during the monsoon season (July to September) (Yackulic *et al*. 2014) and are found primarily along rocky talus shorelines downstream of the LCR where river flow influences habitat availability (Converse *et al*. 1998, Valdez and Ryel 1995). River flows <6,000 cfs can reduce the amount of inundated talus shoreline and the availability of interstitial spaces used by young and juvenile humpback chub for resting, predator avoidance, and feeding. Young humpback chub use shallow shoreline habitats throughout their first summer, at low water velocities and depths less than 3.3 ft (1 m) (Valdez and Ryel 1995, 1997). They shift location as they grow larger and by fall and winter, are found in deeper habitats with higher water velocities and depths up to 4.9 ft (1.5 m). Effects from reservoir releases (and, thus, shoreline habitat) are not expected for adult humpback chub because they are not as dependent on these low-velocity shoreline habitats, which are affected by flow-related changes. Similar effects would also occur in the eight mainstem aggregations of humpback chub. The western Grand Canyon population is unlikely to be substantially affected by daily fluctuations in release volumes because the hydraulic effects of lower-volume releases diminish with distance downstream as flow waves attenuate. As a result, changes in discharge become less pronounced farther downstream where this population occurs.

Effects of the Action on Critical Habitat

Water quantity and quality and associated humpback chub habitat in the LCR are affected primarily by perennial springs in the lower sections and seasonally by runoff from tributaries in the upper sections. The areas typically used for spawning are likely too far from the confluence to be affected by changes to the Colorado River. The proposed action is not expected to affect the PBFs of critical habitat in the LCR and therefore is not discussed further. Critical habitat for the humpback chub above Glen Canyon Dam extends down the Colorado River to Imperial Canyon (3,680 ft elevation), which is about 1.5 mi (2.4 km) into the full pool elevation of Lake Powell (3,700 ft). This area is rarely inundated by lake elevation and therefore is not discussed

further. There is no critical habitat for humpback chub elsewhere in the full pool of Lake Powell or Lake Mead. The only section of critical habitat for humpback chub that may be affected by the proposed action is the 174 mi (280 km) of the Colorado River below Glen Canyon Dam from Nautiloid Canyon to Granite Park.

Below is a summary of potential effects on critical habitat PBFs.

PBF 1: *Water: Consists of water of sufficient quality (i.e., temperature, dissolved oxygen, lack of contaminants, nutrients, turbidity, etc.) that is delivered in sufficient quantity to a specific location in accordance with a hydrologic regime that is required for the specific life stage for each species.*

Effect: In most cases, the Proposed Action would deliver water of sufficient quantity and quality to the specific locations that humpback chub occur in accordance with a hydrologic regime that is required for specific humpback chub life stages. The proposed action is not anticipated to have additional adverse effects on water quantity and quality beyond those described in the LTEMP Biological Opinion (USFWS 2016a).

As stated in the Environmental Baseline above, Glen Canyon Dam operations have modified water quality and quantity by altering flow regimes and water temperatures. Since 1996, Reclamation has adaptively managed water releases from Glen Canyon Dam to improve water quality and quantity for humpback chub in the Colorado River through Grand Canyon (DOI 1996). These modified flows reduced daily fluctuations in river flow from peak power plant releases and allowed for higher spring releases to restore some aspects of the natural hydrograph. The Proposed Action includes the potential for less water to be released to protect Lake Powell elevations. A reduction in flow within a day or days could result in a reduction or loss of larval fish habitat. However, although we anticipate adverse effects on this PBF from the Proposed Action, we do not anticipate that the Proposed Action would compromise this PBF's function and conservation role because the Proposed Action would deliver water of sufficient quantity and quality to the specific locations humpback chub occur in accordance with a hydrologic regime that is required for specific humpback chub life stages.

PBF 2: Physical Habitat: This includes areas of the Colorado River system that are inhabited by fish or potentially habitable for use in spawning, nursery, feeding, or corridors between these areas. In addition to river channels, these areas include bottomlands, side channels, secondary channels, oxbows, backwaters, and other areas in the 100-year floodplain, which when inundated provide spawning, nursery, feeding, and rearing habitats, or access to these habitats.

Effect: The Proposed Action may result in adverse effects on the physical habitat PBF. When daily minimum flows are 5,000 to 6,000 cfs physical habitat (talus shorelines, backwaters, *etc*.) for spawning, nursery, feeding, and rearing may be adversely by the proposed action. Lower flows will affect the position of the water-shoreline interface used by young-of-year and juvenile humpback chub. Low river flows because of dam operations could affect the availability of backwater habitat. The effects are dependent upon flow conditions prior to the occurrence of lower flow releases and the elevation of sandbars that form backwaters. Therefore, although we expect that at some point during the life of the project, physical habitats will be adversely affected, we do not think that the lower daily flows would result in the loss of spawning, nursery,

feeding, or movement corridors such that this PBF is no longer available.

Feeding areas are currently available to all life stages, especially for adult fish as indicated by condition factor of adult fish in the mainstem compared to those in the LCR (Meretsky *et al*. 2000, Hoffnagle *et al*. 2006), and we do not anticipate this will change under the Proposed Action. However, fluctuating flows may temporally modify nursery and feeding habitat for juvenile humpback chub if these flows alternately flood and dewater mainstem nearshore habitats important to early humpback chub life stages and by the loss of sediment-formed habitats. The Proposed Action could result in reduced annual water releases than are currently released under LTEMP (DOI 2016a, b) but would not go below 5 maf (DOI 2026a).

Although the Proposed Action may result in adverse effects on this PBF, we do not anticipate that the Proposed Action would compromise this PBF's function and conservation role because the Proposed Action will continue to provide physical habitat that supports spawning, nursery, feeding, and rearing habitats throughout the action area.

PBF 3: Biological Environment: Food supply, predation, and competition are important elements of the biological environment and are considered components of this constituent element. Food supply is a function of nutrient supply, productivity, and availability to each life stage of the humpback chub. Predation, although considered a normal component of this environment, is out of balance due to introduced fish species in some areas. This is also true of competition from non-native fish species.

Effect: We anticipate that with warmer water and lower flows, there may be increases in humpback chub food supply. However, the lower Lake Powell elevations and warmer water are also likely to increase predation and competition from warm water non-native fish, such as the highly piscivorous and competitive smallmouth bass and green sunfish.

Food supply is a function of many factors including algae production, nutrient concentrations, discharge regimes, turbidity levels, substrate quality, tributary flooding, and the diversity and species composition of invertebrate assemblages (Stevens *et al*. 1997, Cross *et al.* 2013, Behn and Baxter 2019, Scholl *et al*. 2023). As lower flows decrease the depth of the river under 5,000 to 6,000 cfs hourly flows, we anticipate an increase in humpback chub food supply. Low turbidity in the tailwater permits increased algae growth on bottom substrates (Angradi 1994, Shannon *et al*. 1994) and supports extremely high invertebrate biomass in the tailwater reach of Glen Canyon Dam (Blinn *et al*. 1994, Stevens *et al*. 1997, Cross *et al*. 2011). This may be a beneficial result of warmer water.

The most substantial effect on this PBF from the Proposed Action will be the increase in entrainment of smallmouth bass and other warm water non-native predators and competitors of humpback chub. The Proposed Action under the existing climate will result in lower lake elevations and warmer temperatures that could lead to the establishment of warm water non-native invasive species, such as smallmouth bass, which are known to compete with and predate on humpback chub (Loppnow *et al*. 2013, USFWS 2018a). Reclamation included conservation measures in the Proposed Action (see Conservation Measures section) to minimize the potential for smallmouth bass entrainment as well as detect and remove smallmouth bass before they can establish below Glen Canyon Dam. To date, only flow measures such as Cool Mix have been

successful at abating establishment of smallmouth bass, but we support all management actions that reduce entrainment and/or disrupt warm water non-native fish below Glen Canyon Dam. Ongoing monitoring and development of a targeted smallmouth bass monitoring plan will assist with determining the efficacy of the non-flow conservation measures.

At this time, based upon the information we have and the anticipated implementation of conservation measures, although we anticipate adverse effects on this PBF from the Proposed Action, we acknowledge that Reclamation is going to implement conservation measures to reduce entrainment and establishment of smallmouth bass as well as other warm water non-native fish. We think the ability of this PBF to continue to fulfill its function and conservation role will be dependent upon successful implementation of all conservation measures.

Razorback Sucker and Critical Habitat

Effects of the Action on the Species

The Proposed Action will primarily affect razorback suckers through changes in the elevation of Lake Powell that will alter downstream river temperature, change the number of smallmouth bass entrained through Glen Canyon Dam, and affect the population growth of smallmouth bass below the dam. Additionally, proposed daily flows released from Glen Canyon Dam will alter shoreline habitat. At Lake Powell full pool (3,700 ft), water quality remains stable. When lake levels drop, areas of shoreline and historical sediment deposits become exposed. During high spring inflows, these sediments can be remobilized, leading to low oxygen conditions in the middle of the reservoir. These oxygen-depleted zones can be transported toward Glen Canyon Dam, potentially affecting water quality of downstream releases. At low lake elevations (<3,540 ft), sediment resuspension is more likely, which can temporarily increase turbidity and nutrient loads in the reservoir and in dam releases. This process is a continuing dynamic that is expected to be exacerbated by the low lake elevations expected under this proposed action.

Lake Powell Elevations

Effects of Lake Powell Elevation on Colorado River and San Juan River Inflows

Unlike the humpback chub where effects of Lake Powell elevations focus on effects downstream of Glen Canyon Dam, the BA (DOI 2026a) focuses on how Lake Powell elevations may affect razorback sucker and their habitat at the inflows of the Colorado and San Juan rivers. Higher or lower lake elevations can shift habitat from between lentic (lake-like) and lotic (riverine) conditions. Because most razorback suckers in the action area occur in these inflow areas, lake elevation is an important factor influencing the amount and quality of available habitat, as well as conditions affecting fish passage and critical habitat.

The elevation of Lake Powell is not expected to affect razorback sucker distribution in the inflow areas, but it could affect population connectivity upstream of Glen Canyon Dam. The Piute Farms waterfall in the San Juan River inflow completely blocks upstream movement of fish from the inflow to the river. The waterfall is about 3 mi (4.8 km) downstream of Clay Hills at a top elevation of about 3,660 ft, and it has existed since 2001 (DOI 2026a). A lake elevation of approximately 3,666.5 ft is necessary for fish passage over the waterfall; however, Piute Farms waterfall is a desirable fish barrier to prevent upstream movement of non-native fish from Lake

Powell into the San Juan River.

Effects of Lake Powell Elevations Below Glen Canyon Dam

Although razorback suckers are still relatively rare in the action area below Glen Canyon Dam, as noted in the Environmental Baseline section, the stocking of razorback suckers in the LCR and Havasu Creek is showing promise of increasing their population along with razorbacks that occur in western Grand Canyon. The effects discussion regarding the effects of smallmouth bass on humpback chub applies to the razorback sucker (please see Effects of the Action, Lake Powell Elevations section, above). Low Lake Powell elevations that increase the entrainment rate and entrainment survival of smallmouth bass, will result in a positive smallmouth bass population growth rate (Eppehimer *et al*. 2024). Smallmouth bass entrained through Glen Canyon Dam can move downstream and may establish a self-sustaining population. If smallmouth bass are established in Grand Canyon, they have the potential to substantially adversely affect razorback sucker persistence in the action area below Glen Canyon Dam.

Daily Releases from Glen Canyon Dam

Reclamation anticipates that low base flows of less than 6,000 cfs will desiccate or reduce the volume of the backwater and reduce its value as razorback sucker nursery habitat and that flows of ≥6,000 cfs may sustain some backwaters habitat for larval razorback suckers. Alternatively, razorback sucker larvae that are hatched in large cobble/gravel bars off the mouths of Diamond Creek, Spencer Canyon, and Salt Creek could drift 30–60 mi (48–97 km) downstream to nursery habitat in the Lake Mead inflow (Albrecht *et al*. 2017), but their upstream return as adults could be blocked by persistence of the Pearce Ferry Rapid. Razorback suckers may use tributary mouths (*e.g*., LCR, Bright Angel Creek, Shinumo Creek, Tapeats Creek, Kanab Creek, Havasu Creek) as habitat for spawning and rearing young, but likely, flows of less than 6,000 cfs would reduce habitat area, access to these inflows, possibly food productivity, and flow velocity that cleans sediments from spawning gravels. Therefore, it is likely that low flows may result in adverse effects on razorback sucker habitat.

The Proposed Action will release warm water from low reservoir elevations that will maintain warm conditions for fish downstream of Glen Canyon Dam. Warm temperatures are expected to benefit the razorback sucker by increasing metabolic rates and growth, and possibly food production. Warmer water releases from Glen Canyon Dam, in the absence of non-native fish, would be beneficial for razorback sucker growth. We would expect that razorback sucker numbers could increase where water temperatures increase and non-natives are rare (Dibble *et al*. 2021). Unfortunately, currently, warm water releases and low Lake Powell elevations are not a benefit to the razorback sucker below Glen Canyon Dam unless ongoing and future conservation actions inhibit smallmouth bass establishment.

Effects of the Action on Critical Habitat

Within the action area, designated critical habitat occurs in the Colorado River and San Juan River inflows to Lake Powell and in the Colorado River–Paria River confluence downstream to Pearce Ferry. Below is a summary of potential effects on critical habitat PBFs.

PBF 1: *Water: This includes a quantity of water of sufficient quality (i.e., temperature, dissolved*

oxygen, lack of contamination, nutrients, turbidity, etc.) that is delivered to a specific location in accordance with a hydrological regime that is required for specific life stages.

Effect: The proposed action is not likely to alter water quantity or water quality within designated razorback sucker critical habitat in the Colorado River and San Juan River inflows to Lake Powell because those critical habitat reaches occur at elevations above approximately 3,600 ft, which is modeled to occur only 4% of the time (DOI 2026a). Lake Powell elevation may influence turbidity and suspended organic material in the inflow reaches, with higher lake elevations generally associated with lower erosion and turbidity, and lower lake elevations associated with increased channel erosion that resuspends sediments and organic material. These processes may influence food production and turbidity but are expected to remain within conditions suitable for razorback sucker.

Minimum daily releases from Glen Canyon Dam of 6,000 cfs or greater should maintain adequate water quantity and suitable water quality conditions within designated razorback sucker critical habitat. Dissolved oxygen levels in the Glen Canyon reach may decrease due to increased deltaic sediment resuspension in Lake Powell and associated dissolved oxygen demand in the reservoir water column (Wildman and Hering 2011, Deemer *et al*. 2023). However, this is not expected to negatively affect water quality because the water is fully oxygenated by the time it reaches Badger Rapid (RM 8; 23 mi [37 km] below the dam).

Although we anticipate adverse effects on this PBF from the Proposed Action, we do not anticipate that the Proposed Action would compromise this PBF's function and conservation role. The Proposed Action would deliver water of sufficient quantity and quality to potential razorback sucker habitat in accordance with a hydrologic regime that is required for specific razorback sucker life stages

PBF 2: Physical habitat: This includes areas of the Colorado River system that are inhabited by razorback suckers or potentially habitable for use in spawning, nursery, feeding, rearing, or corridors between these areas. In addition to river channels, these areas also include bottomlands, side channels, secondary channels, oxbows, backwaters, and other areas in the 100-year floodplain, which, when inundated, provide spawning, nursery, feeding, and rearing habitats.

Effect: The Proposed Action is expected to have a positive effect on razorback sucker food supply. Lower monthly water releases may increase food base production because 1) lower release volumes would decrease the range in daily stage fluctuations, which may increase survival of sensitive insect eggs and increase overall insect abundance; and 2) food base production tends to accelerate when flows are low and photosynthetic productivity is higher (DOI 2026a). Water temperature is likely to have a positive effect on the food base because the temperatures are expected to be warmer than 54°F (12°C).

Within Lake Powell and the inflows to Lake Powell, physical habitat conditions within razorback sucker critical habitat are expected to remain largely unchanged under the Proposed Action (DOI 2026a). Above Lake Powell, we do not anticipate that the Proposed Action will inundate the Colorado and San Juan River inflows above 3,600 ft over the life of the project (10 years). In the inflow areas to Lake Powell, the location of the river–reservoir interface would shift slightly as

reservoir elevations change; however, juvenile and adult razorback suckers are expected to move with these shifting inflow locations (DOI 2026a). The Colorado and San Juan rivers would remain connected to Lake Powell, and riverine habitat suitable for spawning, nursery, feeding, and rearing would continue to be available. As lake elevations fluctuate, the relative extent of lotic and lentic habitat may change, but both habitat types are used by razorback suckers and would remain present in the inflow areas.

Downstream of Glen Canyon Dam in the Grand Canyon, some reduction in backwater habitat could occur under lower flow conditions (<6,000 cfs); however, backwaters naturally shift in location and persistence with changes in river flow and stage. These dynamics are unlikely to decrease the overall amount of backwater habitat available within critical habitat. In addition, backwaters are typically rare within this critical habitat reach. Minimum daily releases of 6,000 cfs or greater are expected to maintain complex shoreline habitats, riffles, eddies, and pools that provide spawning, feeding, and rearing habitats. When flows are between 5,000 and 6,000 cfs, some reduction in shallow shoreline or backwater habitats may occur, but other habitat types would remain available, and habitat locations would most likely shift rather than be eliminated.

Overall, the Proposed Action is unlikely to substantially adversely affect the physical habitat PBF because river habitats upstream of Lake Powell would remain connected to the reservoir. Additionally, in the Grand Canyon, the range of habitat types used by the species would continue to be present, although their locations may shift with changing flow and reservoir conditions. Therefore, we do not anticipate that the Proposed Action would compromise this PBF's function and conservation role.

PBF 3: *Biological environment: Food supply, predation, and competition are important elements of the biological environment and are considered components of this constituent element. Food supply is a function of nutrient supply, productivity, and availability to each life stage of the razorback sucker. Predation, although considered a normal component of this environment, may be out of balance due to introduced fish species in some areas. This may also be true of competition, particularly from non-native fish species.*

Effect: The biological environment within razorback sucker critical habitat consists primarily of the food base, mainly drifting and benthic aquatic macroinvertebrates, and warm water non-native fish species (*i.e.*, smallmouth bass) that may function as predators and/or competitors.

Under the Proposed Action, biological productivity is expected to remain suitable for razorback sucker. In the inflows to Lake Powell, variations in reservoir elevation may influence erosion and suspended organic material, which can increase turbidity and support macroinvertebrate production that is the primary food base for the species. Downstream in the Grand Canyon, reduced flows may result in warmer water temperatures. Razorback suckers are adapted to warm water conditions, and warmer temperatures may increase metabolic rates and productivity of the aquatic food base, potentially benefiting food supply for the species (USFWS 2018c).

The most substantial effect on this PBF from the Proposed Action will be the increase in entrainment of smallmouth bass and other warm water non-native predators. The Proposed Action under the existing climate will result in lower lake elevations and warmer temperatures that could lead to the establishment of warm water non-native invasive species, such as

smallmouth bass, which are known to predate on razorback suckers (USFWS 2018c). Reclamation included conservation measures in the Proposed Action (see Conservation Measures section) to minimize the potential for smallmouth bass entrainment as well at detect and remove smallmouth bass before they can establish below Glen Canyon Dam. To date, only flow measures such as Cool Mix have been successful at abating establishment of smallmouth bass, but we support all management actions that reduce entrainment and/or disrupt warm water non-native fish below Glen Canyon Dam. Ongoing monitoring and development of a targeted smallmouth bass monitoring plan will assist with determining the efficacy of the non-flow conservation measures.

At this time, based upon the information we have and the anticipated implementation of ongoing and new conservation measures, although we anticipate adverse effects on this PBF from the Proposed Action, we acknowledge that Reclamation is going to continue to implement ongoing conservation measures as well as new measures to reduce entrainment and establishment of smallmouth bass as well as other warm water non-native fish. The ability of this PBF to continue to fulfill its function and conservation role will be dependent upon successful implementation of all new and ongoing conservation measures.

CUMULATIVE EFFECTS

Cumulative effects are those effects of future State or private activities, not involving federal activities, that are reasonably certain to occur within the action area considered in this biological opinion (50 CFR §402.02).

The Colorado River Watershed within the action area, both above and below Glen Canyon Dam is predominately managed by the NPS. Since the land within the action area is almost exclusively managed by the NPS, most activities that could potentially affect listed species are Federal activities and subject to additional section 7 consultations.

Cumulative effects on the humpback chub, razorback sucker and their designated critical habitats outside of NPS lands stem from Native American actions, and State, local, or private actions in tributary watersheds upstream of the action area. Native American use of the Colorado River in Grand Canyon includes cultural, religious, and recreational purposes, as well as land management of tribal lands (*e.g.*, recreational use including rafting, hunting, and fishing). These uses are projected to have minimal effects on humpback chub, razorback sucker and their designated critical habitats due to the small scale at which they occur.

There is the potential for non-native fishes, including those hosting parasites, to invade the lower LCR from upriver sources 155 mi (250 km) away during certain flood events travelling through the intermittent river segments (Stone *et al.* 2007). Non-native fishes stocked in the area in Arizona utilizing federal funds have been evaluated under section 7 and are not anticipated to substantially affect humpback chub, razorback sucker, and their critical habitats (USFWS 2021).

Non-Federal actions on the Paria River and Kanab Creek are limited to small developments, private water diversions, and recreation, and are expected to continue to have little effect on humpback chub and its critical habitat because these effects are diffuse over a wide area and are distant from known humpback chub and razorback sucker populations, and their critical habitats.

Increased uranium mining on state and private lands could increase the amount of uranium, arsenic, and other trace elements in local surface water and groundwater flowing into the Colorado River (Alpine 2010). Uranium, other radionuclides, and metals associated with uranium mines can affect the survival, growth, and reproduction of aquatic biota. However, aquatic biota and habitats most likely to be affected during mine development and operation are those associated with small, ephemeral, or intermittent drainages, which are not areas used by humpback chub or razorback sucker in the action area and do not connect to habitats used by these fish within the action area.

In addition, although the LCR stretches almost 340 mi (550 km), only the headwaters and the lowermost reaches flow year-round. The lower 13 mi (21 km) of the LCR is fed by groundwater springs. As stated earlier in the document, this reach of the LCR is occupied by the largest self-sustaining population of humpback chub, and the lower 8 mi (13 km) is designated humpback chub critical habitat. These water sources may also be vulnerable to basin-wide drought and climate change affecting overall habitat availability for the humpback chub and razorback sucker. As the population in the Basin States grows and expands, municipal, industrial, and agricultural water demand continues to increase. A study in 2012 showed that the demand for Colorado River Basin water may exceed supply before 2060 (DOI 2012b), which may continue to affect Glen Canyon Dam operations and changes in flow, sediment, and water temperature regimes in the action area.

INTEGRATION AND SYNTHESIS

Jeopardy Analysis

In accordance with our regulations (see 50 CFR §402.02, §402.14(g)), the FWS evaluates the status of the species, environmental baseline, effects of the action, and cumulative effects to determine whether the project is likely to "jeopardize the continued existence of…" a species. This means to "engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and the recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species." Thus, in making this determination for each species, we must look at whether the proposed action directly or indirectly reduces the reproduction, numbers, or distribution of a listed species. Then, if there is a reduction in one or more of these elements, we evaluate whether it would be expected to cause an appreciable reduction in the likelihood of both survival and recovery of the species.

The 1998 Endangered Species Consultation Handbook defines survival and recovery as they apply to the Act's jeopardy standard. Survival means "the species' persistence…beyond the conditions leading to its endangerment, with sufficient resilience to allow recovery from endangerment." Survival is the condition in which a species continues to exist in the future while retaining the potential for recovery. Recovery means "improvement in the status of a listed species to the point at which listing is no longer appropriate under the criteria set out in Section 4(a)(1) of the Act." Recovery is the process by which species' ecosystems are restored and/or threats to the species are removed so self-sustaining and self-regulating populations of these species can be supported as persistent members of native biotic communities.

Destruction and Adverse Modification Analysis

"Destruction or adverse modification" means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the PBFs essential to the conservation of a species or that preclude or significantly delay development of such features. (50 CFR §402.02). Thus, in making this determination for each critical habitat, we must look at whether the proposed action directly or indirectly alters critical habitat such that its value for the conservation of a listed species is appreciably diminished. Alterations that may destroy or adversely modify critical habitat may include impacts on the area itself, such as those that would impede access to or use of the essential features. The FWS will generally conclude that a federal action is likely to "destroy or adversely modify" designated critical habitat if the action results in an alteration of the quantity or quality of the essential PBFs of designated critical habitat, or that precludes or significantly delays the capacity of that habitat to develop those features over time, and if the effect of the alteration is to appreciably diminish the value of critical habitat for the conservation of the species. This analysis considers the geographic and temporal scope of the proposed action, recognizing that "functionality" of critical habitat necessarily means that it must now and must continue in the future to support the conservation of the species and its progress toward recovery. Destruction or adverse modification does not depend strictly on the size or proportion of the area adversely affected, but rather on the role the action area serves regarding the function of the overall designation, and how that role is affected by the action.

For purposes of making the destruction or adverse modification determination, the FWS evaluates if the effects of the project, taken together with the environmental baseline and cumulative effects, when added to the conservation value of critical habitat are likely to appreciably diminish the role of the critical habitat for the conservation of listed species. The key to making this finding is clearly establishing the role of critical habitat in the action area relative to the value of critical habitat and how the effects of the project, taken together with cumulative effects, are likely to alter that role.

Humpback Chub and Critical Habitat

Jeopardy Analysis

Survival

The Effects of the Action section describes how the FWS anticipates that the Proposed Action would result in adverse effects on humpback chub. To examine the future survival, or viability, of a species, the FWS evaluates the species' resiliency, redundancy, and representation across its range. In this context, the FWS can evaluate how the effects of the Proposed Action are likely to affect the humpback chub's resiliency, redundancy, and representation.

Resiliency describes the ability of a species to withstand (*i.e.*, survive) environmental and demographic stochasticity and is best evaluated through population-level characteristics. Environmental stochasticity includes random fluctuations in the environment, such as spatiotemporal variations in temperature or precipitation, while demographic stochasticity includes random variation in demographic rates, such as mortality and fecundity (USFWS

2016b). Stochastic events that have the potential to affect humpback chub include fluctuations in water temperature and availability and non-native competitors and predators. In general, to be resilient to these stressors, populations need an abundance of individuals that have a sufficient quantity and quality of habitat to maintain genetic diversity, survival, and recruitment (USFWS 2016b). Without these factors, individual populations have an increased likelihood for localized extirpation. Humpback chub have many traits that enable individuals to be resilient in the face of environmental or demographic stochasticity including long life span, high reproductive potential, use of habitats and turbidity that are arduous to other species, adaptation to a wide variety of flow and thermal regimes, and a variable omnivorous diet (USFWS 2018a). Population resiliency is demonstrated by a variety of traits including persistence of small populations (Cataract Canyon), population increases over many years of decline (Grand Canyon), increases after translocations (Havasu Creek), and potential stabilization of declines (Black Rocks and Westwater Canyon). In addition, the current population size of the Grand Canyon protects it from a variety of potential threats.

Habitat factors that influence the resiliency of humpback chub populations include diverse rocky canyon river habitat, suitable flow, suitable temperature, adequate and reliable food supply, habitat with few non-native predators and competitors, suitable water quality, and habitat connectivity (USFWS 2018a). Of these factors, the Proposed Action is reasonably certain to contribute to warmer water temperatures that support increased growth and food supply. The Proposed Action is also anticipated to result in increased entrainment of smallmouth bass below Glen Canyon Dam; therefore, there will be adverse effects and a reasonable likelihood of take from predation and competition. Reclamation is going to implement conservation measures to limit the entrainment of, as well as detect, and remove smallmouth bass. However, because Lake Powell lake elevations are anticipated to remain below 3,570 ft over the life of the Proposed Action, this is likely to create conditions where predation and competition from smallmouth bass results in lethal and sublethal effects on humpback chub, reducing the resiliency of the species in the action area. Under current and expected weather and climatic conditions, the Proposed Action is likely to lead to continued warming of the Lees Ferry stretch of Colorado River below the dam. Smallmouth bass entrained through the dam will encounter warm water habitat that facilitates their survival, growth, and successful spawning and recruitment (Dibble *et al.* 2021, Eppehimer *et al*. 2025). The source of smallmouth through the dam with receptive habitat on the downstream side improves the potential for smallmouth to establish as self-sustaining population.

Representation describes the ability of a species to adapt to changing environmental conditions over time and encompasses both near-term and long-term changes in abiotic (*e.g*., climate patterns, habitat conditions) and biotic (*e.g*., pathogens, competitors, predators) parameters (USFWS 2016b). Representation is characterized by the breadth of genetic diversity or ecological settings observed within and among populations. Species with more diversity likely have more capacity for adapting to changes (natural or anthropogenic) in their environment (Nicotra *et al*. 2015). To maintain the evolutionary potential of the humpback chub, the adaptive genetic or ecological diversity and the evolutionary processes that drive adaptation need to be maintained. This requires persistence of multiple resilient humpback chub populations throughout the species historical range, and the maintenance or creation of historical patterns of gene flow.

The Species Status Assessment for the Humpback Chub (USFWS 2018a) evaluated the current condition of six analysis units, including two within the action area: the LCR and the western Grand Canyon complexes. The LCR Complex exhibits strong reproduction, high adult and sub-adult abundance, and a stable trajectory. The western Grand Canyon Complex is also thriving, with an expanding range, successful mainstem reproduction, and increasing population numbers (Dzul *et al*. 2026). Within the action area, humpback chub occur within 297 mi (478 km) of the Grand Canyon, in addition to tributaries of the LCR, Havasu Creek, and Bright Angel Creek. The LCR and western Grand Canyon humpback chub populations appear to represent a single, genetically similar unit distributed throughout Grand Canyon and its tributaries, that is different from Upper Basin humpback chub populations.

Redundancy describes the ability of a species to withstand and recover from catastrophic events (USFWS 2016b). Increased redundancy reduces the risk that a large portion of the species' range will be negatively affected by a natural (*e.g.*, major drying event or flood) or anthropogenic (*e.g*., introduction of non-native species) catastrophic event and minimizes the effect of localized extirpation on the range-wide persistence of a species (Shaffer and Stein 2000, Redford *et al*. 2011). A species' ability to withstand large catastrophic events is correlated with the number and distribution of its populations. Species that are well-distributed across their historical ranges are considered less susceptible to extinction and more likely to be viable than species confined to small portions of their ranges (Carroll *et al*. 2010). The more populations, and the wider the distribution of those populations, the more redundancy the species will exhibit.

The current distribution of the humpback chub provides a sufficient level of redundancy (USFWS 2018a). Redundancy for the humpback chub is characterized by having multiple populations and metapopulations (*i.e*., groups of populations that are potentially hydrologically connected) that display resilience and are distributed across the species' historical range. Within the action area there are two self-sustaining humpback chub population (LCR and western Grand Canyon) and nine aggregations spread throughout the mainstem Colorado River. Range wide, humpback chub occupy approximately 74% of their historical range, though the Upper Basin populations are currently more vulnerable than the Lower Basin populations due to their lower resiliency (USFWS 2018a).

Water temperature and non-native fish are the primary influences of the future viability of humpback chub in the action area. Water temperatures are dependent on Lake Powell elevations and the depths from which the dam penstocks and/or river works outlets draw water. Since 2000, the Colorado River Basin has been experiencing one of the worst multi-decadal droughts of the last 1,200 years (Gangopadhyay *et al*. 2022). Reduced inflows from the Colorado and San Juan rivers into Lake Power will continue to result in increased water temperatures and decreased lake elevations. The Proposed Action will likely result in continued warm water releases, which would be beneficial for humpback chub (Dibble *et al*. 2021). However, warmer water temperatures combined with lower reservoir elevations could also increase non-native fishes in the Grand Canyon. The recent increase in smallmouth bass, as well as other potentially detrimental non-native fish, is a result of dam operations pulling water from lower lake elevations, which will continue under the Proposed Action. Because of this, it is reasonably certain that the resiliency, redundancy, and representation of the humpback chub will be negatively affected within the action area. To address these effects, Reclamation intends to implement both new and ongoing conservation measures that are designed to limit the

establishment and negative effects (predation and competition) of warm water non-native fish, particularly smallmouth bass, on humpback chub.

Although adverse effects will occur, the Proposed Action will not affect the range-wide survival of the humpback chub because it will not affect humpback chub in the Upper Basin. Although the Upper Basin partners (UCREFRP) are conducting massive efforts to improve humpback chub status, populations in the Upper Basin are vulnerable due to low resiliency. Of the three humpback chub populations in the Upper Basin, the Black Rocks/Westwater Canyon population is in moderate condition, Desolation/Gray canyons are in low condition (particularly due to high pressure from non-native fish), and Cataract Canyon is in critically low condition. The future condition of the humpback chub range wide depends upon maintaining high resiliency in the Lower Basin (below Glen Canyon Dam). Because smallmouth bass have not established in the action area, it is our opinion that Reclamation's implementation of the Proposed Action conservation measures will aid in maintaining the humpback chub's resiliency in the action area by reducing entrainment of smallmouth bass and continuing and improving upon early detection and rapid response efforts in coordination with Federal agencies, States, and Tribes. Therefore, effects from the Proposed Action, including implementation of the conservation measures, will not occur to the extent that humpback chub survival will be appreciably reduced.

Recovery

The second revised Humpback Chub Recovery Plan (USFWS 1990) aimed to protect and restore the endangered humpback chub across the Colorado River basin by addressing river flow alterations, habitat loss, and non-native fish predators. UCREFRP continues to collaboratively work towards recovery in the Upper Basin and the Glen Canyon Dam Adaptive Management Program (GCDAMP) contributes to recovery implementation in the Lower Basin and within the action area. The FWS reclassified the humpback chub from endangered to threatened with a 4(d) rule (86 FR 57588), due to substantial improvements in the species' overall status.

In *Wild Fish Conservancy v. Salazar*, 628 F.3d 513 (9th Cir.2010), the Ninth Circuit held that the FWS must identify when a species would pass the tipping point for recovery and determine whether the proposed action would cause the species to reach that tipping point. That case, and subsequent cases addressing "tipping point," involved challenges to biological opinions that analyzed the effects of project-specific federal actions.

The Proposed Action's effects on the humpback chub include the facilitation of movement and potential proliferation of non-native smallmouth bass (as well as other non-native fish) within the Colorado River below Glen Canyon Dam. While we anticipate take of individual humpback chub because of the Proposed Action, there are two self-sustaining populations and nine aggregations that contribute to the redundancy of the one genetic lineage of humpback chub represented in the action area. Additionally, although the Proposed Action will have adverse effects on the humpback chub, the Proposed Action also includes new and ongoing conservation measures that are intended to reduce the potential for smallmouth bass to establish within Grand Canyon. These measures include actions to reduce entrainment of smallmouth bass, disrupt downstream movement of smallmouth bass, remove non-native fish, deter smallmouth access into sensitive habitats (*e.g.*, fyke nets at LCR), and research control of non-native fish as well as other conservation measures. Therefore, the Proposed Action will not meaningfully affect the

ability to reestablish populations within the humpback chub's historical range and will continue necessary population, habitat, and genetic monitoring that is already in place and being implemented (USFWS 2016a). Therefore, the Proposed Action will not impede or prevent recovery implementation.

A tipping point for humpback chub would be the establishment of smallmouth bass below Glen Canyon Dam. If smallmouth did establish (meaning they are reproducing and self-sustaining [DOI 2016a]), it would likely lead to loss of one or more humpback chub aggregations and/or populations, which would negatively affect, and perhaps even preclude the species' recovery. Addressing invasive species, such as smallmouth bass, requires collaboration, preventing the spread of the invasive species, implementing early detection and rapid response efforts in coordination with Federal, State, and Tribal partners, implementing control measures, and improving invasive species data management for decision-making (DOI 2016c). There is uncertainty around smallmouth bass establishment in the action area. However, as part of the Proposed Action, Reclamation will implement conservation measures that are intended to reduce the risk of smallmouth bass establishment. Reclamation is going to fund more efficient and effective monitoring that is developed collaboratively with FWS, NPS, AZGFD, and GCMRC. These conservation measures are intended to prevent further introduction (entrainment) and spread of smallmouth bass in the action area. More importantly, these measures are geared towards continued recovery. If monitoring indicates the conservation measures are not making progress towards controlling smallmouth bass and protecting humpback chub, then this will trigger a reinitiation criteria, but the coordinated, targeted, and collaborative monitoring will ensure we have the information to quickly respond to changing conditions. Therefore, based on our analysis above, the adverse effects of the Proposed Action on individual humpback chub do not scale up across the range of the species (to the species as a whole) such that it precludes achievement of any of the downlisting criteria and are therefore incapable of pushing the humpback chub past a tipping point beyond which recovery can no longer be achieved.

Consequently, while we anticipate that individual humpback chub will experience lethal or sublethal effects (*e.g.*, effects to survival, growth, and recruitment), largely through predation and competition by smallmouth bass, we do not anticipate the Proposed Action would appreciably reduce the likelihood of both the survival and recovery of this species in the wild.

Destruction and Adverse Modification Analysis

The analyses conducted in the previous sections of this Biological Opinion serve to provide a basis to determine whether the proposed actions would be likely to destroy or adversely modify humpback chub designated critical habitat.

The action area includes humpback chub designated critical habitat downstream of Glen Canyon Dam along about 174 mi (280 km) of the Colorado River in Grand Canyon from Nautiloid Canyon (RM 35, distance downstream from Lees Ferry) to Granite Park (RM 209). Critical habitat for humpback chub in the action area also includes approximately 0.25 mi (0.4 km) of the LCR critical habitat reach, which is the area of the LCR affected by mainstem flow. There is a potential for an increase in warm water non-native species, especially smallmouth bass, that could compete with humpback chub for resources and prey on early life stages. Therefore, the Proposed Action will result in adverse effects to the biological environment PBF (specifically

related to increased competition and predation if a warm water non-native fish becomes established or increases).

The critical habitat in the action area currently provides the PBFs of critical habitat and is occupied by humpback chub. Based on the discussion provided in the Effects of the Action section, the critical habitat will continue to serve the function and conservation role of critical habitat for the humpback chub. Consequently, we do not expect that the anticipated effects to designated critical habitat within the action area will rise to a level that would appreciably diminish the value of the critical habitat for the conservation of the species.

Other designated units of critical habitat within Colorado and Utah will not be affected by the Proposed Action and will continue to provide conservation and recovery benefits to the extent they are able. In summary, we anticipate that the critical habitat on the Colorado River in Grand Canyon from Nautiloid Canyon (RM 35, distance downstream from Lees Ferry) to Granite Park (RM 209) will be the only portion of the critical habitat designation affected by the Proposed Action. Currently, all PBFs within the critical habitat reaches are met. Therefore, the critical habitat designation in its entirety is anticipated to continue providing value to the conservation and recovery of the humpback chub. Consequently, we do not expect that the anticipated effects to designated critical habitat within the action area will rise to a level that would appreciably diminish the value of the critical habitat for the conservation of the species.

Razorback Sucker and Critical Habitat

Jeopardy Analysis

Survival

The Effects of the Action section describes how the FWS anticipates that the Proposed Action would result in adverse effects on razorback sucker. To examine the future survival, or viability, of a species, the FWS evaluates the species' resiliency, redundancy, and representation across its range. In this context, the FWS can evaluate how the effects of the Proposed Action are likely to affect the razorback sucker's resiliency, redundancy, and representation.

Resiliency describes the ability of a species to withstand (*i.e.*, survive) environmental and demographic stochasticity and is best evaluated through population-level characteristics. Environmental stochasticity includes random fluctuations in the environment, such as spatiotemporal variations in temperature or precipitation, while demographic stochasticity includes random variation in demographic rates, such as mortality and fecundity (USFWS 2016b). Stochastic events that have the potential to affect razorback suckers include historical climate variability. In general, to be resilient to stressors, populations need an abundance of individuals that have a sufficient quantity and quality of habitat to maintain genetic diversity, survival, and recruitment (USFWS 2016b). Without these factors, individual populations have an increased likelihood for localized extirpation. Demographic factors that affect the resiliency of razorback sucker are adult population size (wild + stocked fish), spawning and larval presence, recruitment, dependence on stocking, genetic integrity and population stability (wild recruited adults). Habitat factors that influence the resiliency of razorback sucker populations include spawning, nursery and adult habitat, presence of non-native predators, water quality and

temperature, variable flow (lotic only), adequate food and connectivity. Of these factors, the Proposed Action is reasonably certain to contribute to warmer water temperatures that support increased growth and food supply. The Proposed Action is also anticipated to result in increased entrainment of smallmouth bass below Glen Canyon Dam; therefore, there will be adverse effects and a reasonable likelihood of take of razorback suckers from predation. Reclamation is going to implement conservation measures to limit the entrainment of, as well as detect, and remove smallmouth bass. However, because Lake Powell lake elevations are anticipated to remain below 3,570 ft the Proposed Action is likely to create conditions where non-native species adversely affect razorback suckers, reducing the resiliency of the species in the action area.

Representation describes the ability of a species to adapt to changing environmental conditions over time and encompasses both near-term and long-term changes in abiotic (*e.g*., climate patterns, habitat conditions) and biotic (*e.g*., pathogens, competitors, predators) parameters (USFWS 2016b). Representation is characterized by the breadth of genetic diversity or ecological settings observed within and among populations. Species with more diversity likely have more capacity for adapting to changes (natural or anthropogenic) in their environment (Nicotra *et al*. 2015). To maintain the evolutionary potential of the razorback sucker, the adaptive genetic or ecological diversity and the evolutionary processes that drive adaptation need to be maintained. Razorback suckers have shown a high degree of plasticity in their ability to inhabit both lotic and lentic habitats and survive a wide range of environmental conditions. The genetics of the Upper Basin and Lower Basin populations are managed to maintain genetic diversity.

Redundancy describes the ability of a species to withstand and recover from catastrophic events (USFWS 2016b). Increased redundancy reduces the risk that a large portion of the species' range will be negatively affected by a natural (*e.g.*, major drying event or flood) or anthropogenic (*e.g*., introduction of non-native species) catastrophic event and minimizes the effect of localized extirpation on the range-wide persistence of a species (Shaffer and Stein 2000, Redford *et al*. 2011). A species' ability to withstand large catastrophic events is correlated with the number and distribution of its populations. Species that are well-distributed across their historical ranges are considered less susceptible to extinction and more likely to be viable than species confined to small portions of their ranges (Carroll *et al*. 2010). The more populations, and the wider the distribution of those populations, the more redundancy the species will exhibit. Razorback suckers are widely distributed in eight populations across the Colorado River basin living in multiple habitat types and the species is therefore likely to withstand local or even regional catastrophes (USFWS 2018c). Recolonization of catastrophically affected areas would likely occur through direct or indirect stocking efforts as stocked adults commonly migrate between populations in the upper basin and would be expected to recolonize affected areas.

Resource conditions in the Lower Basin range from high to low when examined in isolation of other parameters, except for non-native presence in habitat, which was classified as in extirpated condition for all populations except Lake Mead and the Grand Canyon. Competition and predation from non-native predators, which is exacerbated by lack of cover and turbidity, prevents recruitment in all populations except Lake Mead. Water management and hydropower modify flows in the Lower Basin. The habitat, water temperature and food resources in the Grand Canyon are considered low, but the area is ranked high for non-native presence in habitat

because native fish dominate the Grand Canyon ecosystem and non-native predators and competitors are rare.

Therefore, increasing water temperature and food resources, and maintaining a lack of non-native predatory fish are the primary influences of the future viability of razorback sucker in the action area. Water temperatures are dependent on Lake Powell elevations and the depths from which the dam penstocks and/or river works outlets draw water. Since 2000, the Upper Basin has been experiencing one of the worst multi-decadal droughts of the last 1,200 years (Gangopadhyay *et al*. 2022) and reduced inflows from the Colorado and San Juan rivers into Lake Power will continue to influence both water temperatures and lake elevations. The Proposed Action will likely result in continued warm water releases, which would be beneficial for razorback sucker growth and increased food resources. However, warmer water temperatures combined with lower reservoir elevations could also increase the incidence of non-native predatory fish in the action area. The recent increase in smallmouth bass, as well as other potentially detrimental non-native fish, is a result of dam operations pulling water from lower lake elevations, which will continue under the Proposed Action. Because of this, it is reasonably certain that the resiliency, redundancy, and representation of the razorback sucker will be negatively affected within the action area. Reclamation intends to implement conservation measures that limit the establishment of and control the negative effects of warm water non-native fish, particularly smallmouth bass on razorback suckers. Under current and expected weather and climatic conditions, the Proposed Action is likely to lead to continued warming of the Lees Ferry stretch of Colorado River below the dam. Smallmouth bass entrained through the dam will encounter warm water habitat that facilitates their survival, growth, and successful spawning and recruitment (Dibble *et al.* 2021, Eppehimer *et al*. 2025). The source of smallmouth through the dam with receptive habitat on the downstream side improves the potential for smallmouth to establish as self-sustaining population.

Although adverse effects will occur, the Proposed Action will not affect the range-wide survival of the razorback sucker because it will not affect razorback suckers in the Upper Basin. Therefore, effects from the Proposed Action will not occur to the extent that razorback sucker survival will be appreciably reduced.

Recovery

The current condition of the razorback sucker partially meets the recovery criteria (USFWS 2002b). Demographic criteria in the Upper Basin have been partially met, in both the Green and Colorado River populations. However, all adult razorback suckers are stocked, not wild produced, due to the lack of natural recruitment because of predation and habitat alteration. Demographic criteria in the Lower Basin have also been partially met, as Lake Mead has the only naturally recruiting population in either basin, but abundance is low.

In *Wild Fish Conservancy v. Salazar*, 628 F.3d 513 (9th Cir.2010), the Ninth Circuit held that the FWS must identify when a species would pass the tipping point for recovery and determine whether the proposed action would cause the species to reach that tipping point. That case, and subsequent cases addressing “tipping point,” involved challenges to biological opinions that analyzed the effects of project-specific federal actions.

The Proposed Action's effects on the razorback sucker include the facilitation of movement and potential proliferation of non-native smallmouth bass (as well as other non-native fish) within the Colorado River below Glen Canyon Dam. Although razorback may be increasing within the action area, they are still relatively rare; however, as part of the proposed action Reclamation will fund the FWS and NPS to stock razorback sucker throughout the project area and monitor the outcomes. These actions are intended to aid razorback survival and recovery. Although the Proposed Action will have adverse effects on the razorback sucker, the Proposed Action also includes new and ongoing conservation measures that are intended to reduce the potential for smallmouth bass to establish within Grand Canyon and improve habitat for native fish. These measures include actions to reduce entrainment of smallmouth bass, disrupt downstream movement of smallmouth bass, remove non-native fish, deter smallmouth bass movement into sensitive habitats (*e.g.*, fyke nets at LCR), and research control of non-native fish as well as other conservation measures. Therefore, the Proposed Action will not meaningfully affect the ability to reestablish populations within the razorback sucker's historical range and will continue necessary population, habitat, and genetic monitoring that is already in place and being implemented (USFWS 2016a). Therefore, the Proposed Action will not impede or prevent recovery implementation.

A tipping point for razorback sucker would be the establishment of smallmouth bass below Glen Canyon Dam. If smallmouth did establish (meaning they are reproducing and self-sustaining [DOI 2016a]), it would likely preclude our ability to recover the razorback sucker in the action area. Agency efforts along with improved habitat are just beginning to indicate that existing conditions (*e.g.*, warm water, lack of invasive predators) could support razorback sucker in the action area. Addressing invasive species, such as smallmouth bass, requires collaboration, preventing the spread of the invasive species, implementing early detection and rapid response efforts in coordination with Federal, State, and Tribal partners, implementing control measures, and improving invasive species data management for decision-making (DOI 2016c). There is uncertainty around smallmouth bass establishment in the action area. However, as part of the Proposed Action, Reclamation will implement conservation measures that are intended to reduce the risk of smallmouth bass establishment. Reclamation is going to fund more efficient and effective monitoring that is developed collaboratively with FWS, NPS, AZGFD, and GCMRC, among others. These conservation measures are intended to prevent further introduction (entrainment) and spread of smallmouth bass in the action area. More importantly, these measures are geared towards maintaining recovery options for razorback sucker. If monitoring indicates the conservation measures are not making progress towards control of smallmouth bass, then this may trigger a reinitation criteria, but the coordinated, targeted, and collaborative monitoring will ensure we have the information to quickly respond to changing conditions. Therefore, based on our analysis above, the adverse effects of the Proposed Action on individual razorback suckers do not scale up across the range of the species (to the species as a whole) such that it precludes achievement of any of the downlisting criteria and are therefore incapable of pushing the razorback sucker past a tipping point beyond which recovery can no longer be achieved.

Consequently, while we anticipate that individual razorback suckers will experience lethal or sublethal effects (*e.g.*, effects to survival, growth, and recruitment), largely through predation and competition by smallmouth bass, we do not anticipate the Proposed Action would appreciably reduce the likelihood of both the survival and recovery of this species in the wild.

Destruction and Adverse Modification Analysis

The analyses conducted in the previous sections of this Biological Opinion serve to provide a basis to determine whether the proposed actions would be likely to destroy or adversely modify razorback sucker designated critical habitat.

The action area includes razorback sucker designated critical habitat in the Colorado River and San Juan River inflows and the Colorado River below Glen Canyon Dam from the Paria River downstream to Pearce Ferry. There is a potential for an increase in warm water non-native predatory species, especially smallmouth bass, that could prey on razorback suckers. Therefore, the Proposed Action will result in adverse effects to the biological environment PBF (specifically related to increased competition and predation if a warm water non-native fish becomes established or increases).

The critical habitat in the action area currently provides the PBFs of critical habitat and is occupied by razorback suckers, albeit at low levels. Based on the discussion provided in the Effects of the Action section, the critical habitat will continue to serve the function and conservation role of critical habitat for the razorback sucker. Although reservoir elevations and dam releases may influence turbidity, temperature, and shoreline conditions, these changes are expected to remain within the range of conditions that support razorback sucker habitat and food resources. Physical habitat in the inflow areas would remain connected to Lake Powell, allowing riverine habitats for spawning, nursery, feeding, and rearing to persist, although the location of inflow habitats may shift with reservoir elevation. In the Grand Canyon, some backwater habitats may shift or be reduced under lower flows, but these habitats are naturally dynamic and represent only a small portion of available habitat. Warmer water temperatures associated with reduced flows may increase biological productivity and food availability for razorback suckers, although warmer temperatures will also likely benefit warm water non-native fishes and increase predation or competition. Consequently, we do not expect that the anticipated effects to designated critical habitat within the action area will rise to a level that would appreciably diminish the value of the critical habitat for the conservation of the species.

Other designated critical habitat reaches within Arizona, Colorado, New Mexico, Nevada and Utah will not be affected by the Proposed Action and will continue to provide conservation and recovery benefits to the extent they are able. In summary, we anticipate that the critical habitat within the action area will be the only portion of the critical habitat designation affected by the Proposed Action. Currently, all PBFs within the critical habitat reaches are met. Therefore, the critical habitat designation in its entirety is anticipated to continue providing value to the conservation and recovery of the razorback sucker. Consequently, we do not expect that the anticipated effects to designated critical habitat within the action area will rise to a level that would appreciably diminish the value of the critical habitat for the conservation of the species.

CONCLUSION

Humpback Chub and Critical Habitat

After reviewing the Status of the Species, the Environmental Baseline, and the Effects of the Action, including all measures proposed to avoid and minimize adverse effects, and the

Cumulative Effects, it is our opinion that the Proposed Action is not likely to jeopardize the continued existence of the humpback chub.

The effects on humpback chub associated with the activities from Proposed Action covered under this Biological Opinion, including smallmouth bass entrainment, are not likely to reduce appreciably the likelihood of both the survival and recovery of humpback chub in the wild by reducing reproduction, numbers, or distribution of the species. Therefore, the Proposed Action is not likely to jeopardize the continued existence of the humpback chub.

Although conservation measures are intended to reduce entrainment of smallmouth bass through Glen Canyon Dam and reduce the potential for smallmouth bass to establish populations, because Lake Powell elevations are likely to continue to remain at low levels that facilitate smallmouth bass entrainment, humpback chub will be subject to adverse effects and take is reasonably certain to occur.

The effects on humpback chub critical habitat because of the Proposed Action covered under this Biological Opinion, including the potential for increased predation, are not likely to appreciably diminish the value of critical habitat for the conservation of the humpback chub. Therefore, the Proposed Federal Action is not likely to destroy or adversely modify humpback chub habitat.

Razorback Sucker and Critical Habitat

After reviewing the Status of the Species, the Environmental Baseline, and the Effects of the Action, including all measures proposed to avoid and minimize adverse effects, and the Cumulative Effects, it is our opinion that the Proposed Action is not likely to jeopardize the continued existence of the razorback sucker.

The effects on razorback sucker associated with the activities from Proposed Action covered under this Biological Opinion, including smallmouth bass entrainment, are not likely to reduce appreciably the likelihood of both the survival and recovery of razorback sucker in the wild by reducing reproduction, numbers, or distribution of the species. Therefore, the Proposed Action is not likely to jeopardize the continued existence of the razorback sucker.

Although conservation measures are intended to reduce entrainment of smallmouth bass through Glen Canyon Dam and reduce the potential for smallmouth bass to establish populations, because Lake Powell elevations are likely to continue to remain at low levels that facilitate smallmouth bass entrainment, razorback sucker will be subject to adverse effects and take of is reasonably certain to occur. Because razorbacks are still relatively rare in the action area, as part of the proposed action Reclamation will fund the FWS and NPS to stock razorback suckers throughout the project area and monitor the outcomes. These actions are intended to aid razorback survival and recovery.

The effects on razorback sucker critical habitat because of the Proposed Action covered under this Biological Opinion, including the potential for increased predation, are not likely to appreciably diminish the value of critical habitat for the conservation of the razorback sucker. Therefore, the Proposed Federal Action is not likely to destroy or adversely modify razorback sucker habitat.

INCIDENTAL TAKE STATEMENT

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

HUMPBACK CHUB

AMOUNT OR EXTENT OF TAKE

For the purpose of evaluating incidental take of humpback chub under the Proposed Action, we expect that humpback chub exposed to non-native smallmouth bass (and other warm water non-native fish) will face increased competition for food, shelter, and habitat, along with higher predation risks that reduce their reproductive success and survival at all life stages.

We anticipate that the proposed action is reasonably certain to result in incidental take of humpback chub due to competition and predation from warm water fish, particularly smallmouth bass. We expect this incidental take to be in the form of harm due to smallmouth bass predation and competition as smallmouth bass, or other warm water non-native predatory fish, are entrained through Glen Canyon Dam, survive, and grow in the warming habitat below Glen Canyon Dam and move downstream towards mainstem aggregations (closest aggregation is the 30-Mile aggregation) and the LCR humpback chub population. Other aggregations and the western Grand Canyon population are also at risk; however, we expect the effects of smallmouth bass on humpback chub to occur first among chub closest to Glen Cayon Dam.

The harm is likely to be lethal to eggs, larvae, and juvenile humpback chub and sub-lethal to adult chub. Incidental take of humpback chub will be difficult to detect because finding a predated, dead, or impaired specimen is unlikely and detection of take of eggs and larvae is not possible. Losses may also be masked by seasonal fluctuations in numbers or other causes. However, the following level of take of this species can be anticipated by the extent to which smallmouth bass are gathering/present 0.25 mi (0.4 km) upstream of and within the 30-Mile humpback chub aggregation (RM 29.8–36.3). We anticipate that Reclamation's conservation measures will reduce entrainment and downstream dispersal of smallmouth bass and the coordinated and comprehensive non-native fish monitoring (detection) and removal plan will inform the efficacy of the conservation measures. However, smallmouth bass can multiply quickly and it is not impossible that they may begin to grow, spawn, recruit, and move

downstream, especially with warmer water.

We recognize that providing a numerical estimate of incidental take is the preferred method of measuring take and that for some animals this method is biologically defensible as the ecology of the animal lends itself to them being more detectible (*e.g.*, large mammals with known home ranges). However, it is impossible to quantify the number of humpback chub taken because: (1) dead or impaired individuals are difficult to find and losses may be masked by seasonal fluctuations in environmental conditions; (2) the status of the species could change over time through immigration, emigration, and loss or creation of habitat; and (3) the species is small-bodied, well camouflaged, and occurs under water of varying clarity, and thus individuals are difficult to detect. Per 50 CFR 402.14(i)(1)(i), a surrogate may be used to express the amount or extent of anticipated take when it is not practical to express, or monitor take in terms of individuals of the listed species. For the reasons listed herein it is not practical to express the amount or extent of anticipated take in terms of individuals, thus we will attribute incidental take using the presence of smallmouth bass detected in specific locations as a surrogate for take.

Specifically, we will use a shoal (general gathering of fish in the same area) of adult (≥200 mm) and/or subadult (≥100 mm) smallmouth bass below Glen Canyon Dam and the uppermost chub aggregation (30-Mile) to determine when take is exceeded. The causal link between the presence or gathering of smallmouth bass and take of humpback chub is that when smallmouth bass can find one another, they will be able to spawn and create more smallmouth bass that can lead to establishment of the species within occupied humpback chub habitat. We are identifying a trigger that we think would occur prior to smallmouth bass establishing. By setting a threshold, we have set an incidental take limit that is measurable, irrefutable, and that indicates that the humpback chub is being affected at a level where management needs to change. We are confident that information from the coordinated/collaborative monitoring plan will be able to provide fish community data and inform us as to whether smallmouth bass are present. We conclude that the incidental take of humpback chub will be exceeded if monitoring detects two adult smallmouth bass within RM 0–8 **OR** if 2 adult or 4 subadult smallmouth bass are found in the 2.5 mi (4 km) existing House Rock Juvenile Chub Monitoring (JCM) reach (~RM 17.2–19.4). After locating one adult smallmouth bass between RM 0–8, FWS and Reclamation will meet to discuss how to proceed before a second adult smallmouth bass is detected. FWS will work with Reclamation to design monitoring (see coordinated monitoring plan in the Proposed Action) that will ensure we have confidence that monitoring is sufficient to detect adult and subadult smallmouth bass at the levels specified above. We will work with Reclamation, NPS, GCMRC, and AZGFD to develop the sampling strategy, confidence intervals, and other information needed to detect this change in the development of a coordinated and comprehensive non-native fish monitoring (detection) and removal plan focused on the action area from Glen Canyon Dam to the confluence with the LCR. Once the plan is complete, Reclamation and the FWS will revisit the trigger numbers to confirm they remain appropriate. We are specifically focusing on low levels of captured/detected smallmouth bass because the capture probability of smallmouth bass in large river systems is very low – a small number of captured fish indicates a much larger population that has not been detected. Monitoring data from the Upper Basin indicates smallmouth bass can go from <1% of the fish community to 19% in 3 years (Bestgen *et al*. 2026), which means that it takes very few adult smallmouth bass to produce many offspring.

EFFECT OF THE TAKE

In the accompanying biological opinion, we have determined that the level of anticipated take is not likely to result in jeopardy to the humpback chub. Although we anticipate some incidental take to occur, the implementation of the proposed action as well as conservation measures would ultimately result in avoidance and minimization of adverse effects.

REASONABLE AND PRUDENT MEASURES

In addition to conservation measures included in the Proposed Action, the FWS considers the following reasonable and prudent measure necessary and appropriate to minimize take of the humpback chub:

1. Monitor the effects of the proposed action on humpback chub.
2. Monitor incidental take resulting from the proposed action and report to the FWS the findings of that monitoring.

Terms and Conditions

To be exempt from the prohibitions of Section 9 of the Act, Reclamation must comply with the following terms and conditions, which implement the reasonable and prudent measure described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. The following terms and conditions will implement reasonable and prudent measure 1:
    1.1. Data management is a key strategy for managing smallmouth bass effects on humpback chub (DOI 2021). To monitor the effects of smallmouth bass on humpback chub, as well as to track all native and non-native fish data in the action area, Reclamation shall work with the FWS to do the following:
        1.1.1. Develop a new and/or clone and/or modify an existing application (*e.g.*, the BORG that UCREFRP uses), a centralized cloud-based mobile data collection application that contains a suite of electronic data entry forms and a secure web-based data management portal for viewing, managing, reporting, and analyzing project data in near real time. This type of data collection will enhance workflows, improve the quality of data collected through electronic data collection, and improve access and availability to important fisheries related information so that Reclamation can track incidental take in meaningful timeframe. This is a reasonable ask because model frameworks are already developed and these applications are a cost-effective means of promoting user-friendly, interoperable data collection ensuring accuracy, consistency, and availability of data across DOI agencies so that we can quickly assess the effects of smallmouth bass (and other invasive predatory fish) on humpback chub.
        1.1.2. Develop and/or modify an existing database to use as the database of record for all fisheries data (native and non-native) collected in the action area. The database will provide a centralized location for data that can be accessed by all partners and stakeholders, streamlining and strengthening fish community analysis, thereby

ensuring fish community data is monitored closely and any changes in smallmouth bass density is tracked closer to real time.

1.2. Reclamation shall work with FWS to begin using the data collection application and database for new data no later than July 31, 2027. Reclamation will work with FWS to make contacts with the data collection users, developers, and partners to milestones towards meeting the implementation date.

2. The following terms and conditions will implement reasonable and prudent measure 2:

2.1. Reclamation shall monitor the effects of incidental take resulting from implementation of the Proposed Action and report these findings to FWS annually, by August 1 of each year on the previous year's activities. Incidental take monitoring shall include information such as whether the Proposed Action is implemented as proposed and analyzed in this biological opinion (including conservation measures), native/non-native fish community data, *etc*.

2.2. Reclamation shall work with the FWS to develop a format for annual reporting that is efficient, effective, and provides the necessary to inform incidental take.

RAZORBACK SUCKER

AMOUNT OR EXTENT OF TAKE

For the purpose of evaluating incidental take of razorback suckers under the Proposed Action, we expect that razorback suckers exposed to non-native smallmouth bass (and other warm water non-native fish) will face increased competition for food, shelter, and habitat, along with higher predation risks that reduce their reproductive success and survival at all life stages.

We anticipate that the proposed action is reasonably likely to result in incidental take of razorback sucker due to competition and predation from warm water fish, particularly smallmouth bass. We expect this incidental take to be in the form of harm due to predation and competition as smallmouth bass, or other warm water non-native predatory fish, are entrained through Glen Canyon Dam, survive, and grow in the warming habitat below Glen Canyon Dam and move downstream where razorback suckers occur.

The harm is likely to be lethal to eggs, larvae, and juvenile razorback suckers and sub-lethal to adults. Incidental take of razorback suckers will be difficult to detect because finding a predated, dead, or impaired specimen is unlikely and detection of take of eggs and larvae is not possible. Losses may also be masked by seasonal fluctuations in numbers or other causes. However, the following level of take of this species can be anticipated by the extent to which smallmouth bass are present within 0.25 mi (0.4 km) upstream and downstream of RM 60. We anticipate that Reclamation's conservation measures will reduce entrainment and downstream dispersal of smallmouth bass and the coordinated and comprehensive non-native fish monitoring (detection) and removal plan will inform the efficacy of the conservation measures. However, smallmouth bass can multiply quickly and it is not impossible that they may begin to grow, spawn, recruit, and move downstream, especially with warmer water.

We recognize that providing a numerical estimate of incidental take is the preferred method of

measuring take and that for some animals this method is biologically defensible as the ecology of the animal lends itself to them being more detectible (*e.g.*, large mammals with known home ranges). However, it is impossible to quantify the number of razorback taken because: (1) dead or impaired individuals are difficult to find and losses may be masked by seasonal fluctuations in environmental conditions; (2) the status of the species could change over time through immigration, emigration, and loss or creation of habitat; and (3) the species is small-bodied, well camouflaged, and occurs under water of varying clarity, and thus individuals are difficult to detect. Per 50 CFR 402.14(i)(1)(i), a surrogate may be used to express the amount or extent of anticipated take when it is not practical to express, or monitor take in terms of individuals of the listed species. For the reasons listed herein, it is not practical to express the amount or extent of anticipated take in terms of individuals, thus we will attribute incidental take using the presence of smallmouth bass detected in specific locations as a surrogate for take.

Specifically, we will use a shoal (general gathering of fish in the same area) of adult (≥200 mm) and/or subadult (≥100 mm) smallmouth bass above the highest upstream area razorback suckers currently occur, the confluence of the LCR, to determine when take is exceeded. The causal link between the presence or gathering of smallmouth bass and take of razorback sucker is that when smallmouth are able to find one another, they will be able to spawn and create more smallmouth bass that can lead to establishment of the species within occupied razorback sucker habitat. By setting a threshold, we have set an incidental take limit that is measurable, irrefutable, and that indicates that the razorback sucker is being affected at a level where management needs to change. We are confident that information from the coordinated/collaborative monitoring plan will be able to provide fish community data and inform us as to whether smallmouth bass are present. We conclude that the incidental take of razorback sucker will be exceeded if 2 adult or 4 subadult smallmouth bass are found in the 2.5 mi (4 km) upstream of RM 52 (just above Nankoweap Canyon). After locating any smallmouth bass in this area (or a similar area identified in the coordinated monitoring plan), FWS and Reclamation will meet to discuss how to proceed before additional smallmouth bass are detected. FWS will work with Reclamation to design monitoring (see coordinated monitoring plan in the Proposed Action) that will ensure we have confidence that monitoring is sufficient to detect any smallmouth bass, but specifically adult and subadult smallmouth bass, at the levels specified above. We will work with Reclamation, NPS, GCMRC, and AZGFD to develop the sampling strategy, confidence intervals, and other information needed to detect this change in the development of a coordinated and comprehensive non-native fish monitoring (detection) and removal plan focused on the action area from Glen Canyon Dam to the confluence with the LCR. Once the plan is complete, Reclamation and the FWS will revisit the trigger numbers to confirm they remain appropriate. We are specifically focusing on low levels of captured/detected smallmouth bass because the capture probability of smallmouth bass in large river systems is very low – a small number of captured fish indicates a much larger population that has not been detected. Monitoring data from the Upper Basin indicates smallmouth bass can go from <1% of the fish community to 19% in 3 years (Bestgen *et al*. 2026), which means that it takes very few adult smallmouth bass to produce many offspring. .

EFFECT OF THE TAKE

In the accompanying biological opinion, we have determined that the level of anticipated take is not likely to result in jeopardy to the razorback sucker. Although we anticipate some incidental take to occur, the implementation of the proposed action as well as conservation measures should

minimize adverse effects.

REASONABLE AND PRUDENT MEASURES

The In addition to conservation measures included in the Proposed Action, the FWS considers the following reasonable and prudent measure necessary and appropriate to minimize take of the humpback chub:

1. Monitor the effects of the proposed action on razorback sucker.
2. Monitor incidental take resulting from the proposed action and report to the FWS the findings of that monitoring.

Terms and Conditions

To be exempt from the prohibitions of Section 9 of the Act, Reclamation must comply with the following terms and conditions, which implement the reasonable and prudent measure described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

To be exempt from the prohibitions of Section 9 of the Act, Reclamation must comply with the following terms and conditions, which implement the reasonable and prudent measure described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. The following terms and conditions will implement reasonable and prudent measure 1:
    1.1. Data management is a key strategy for managing smallmouth bass effects on razorback sucker (DOI 2021). To monitor the effects of smallmouth bass on razorback sucker, as well as to track all native and non-native fish data in the action area, Reclamation shall work with the FWS to do the following:
        1.1.1. Develop a new and/or clone and/or modify an existing application (*e.g.*, the BORG that UCREFRP uses), a centralized cloud-based mobile data collection application that contains a suite of electronic data entry forms and a secure web-based data management portal for viewing, managing, reporting, and analyzing project data in near real time. This type of data collection will enhance workflows, improve the quality of data collected through electronic data collection, and improve access and availability to important fisheries related information so that Reclamation can track incidental take in meaningful timeframe. This is a reasonable ask because model frameworks are already developed and these applications are a cost-effective means of promoting user-friendly, interoperable data collection ensuring accuracy, consistency, and availability of data across DOI agencies so that we can quickly assess the effects of smallmouth bass (and other invasive predatory fish) on razorback sucker.
        1.1.2. Develop and/or modify an existing database to use as the database of record for all fisheries data (native and non-native) collected in the action area. The database will provide a centralized location for data that can be accessed by all partners and stakeholders, streamlining and strengthening fish community analysis, thereby

ensuring fish community data is monitored closely and any changes in smallmouth bass density is tracked closer to real time.

1.2. Reclamation shall work with FWS to begin using the data collection application and database for new data no later than July 31, 2027. Reclamation will work with FWS to make contacts with the data collection users, developers, and partners to milestones towards meeting the implementation date.

2. The following terms and conditions will implement reasonable and prudent measure 2:

2.1. Reclamation shall monitor the effects of incidental take resulting from implementation of the Proposed Action and report these findings to FWS annually, by August 1 of each year on the previous year's activities. Incidental take monitoring shall include information such as whether the Proposed Action is implemented as proposed and analyzed in this biological opinion (including conservation measures), native/non-native fish community data, *etc*.

2.2. Reclamation shall work with the FWS to develop a format for annual reporting that is efficient, effective, and provides the data necessary to inform incidental take.

CONSERVATION RECOMMENDATIONS

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

- We recommend Reclamation work with FWS, NPS, and other partners to conduct any analysis needed to continue conducting experimental flows to disadvantage smallmouth bass recruitment (*i.e*., Cool Mix). The existing NEPA for experimental flows to disadvantage smallmouth bass is expiring. We think it would be beneficial to have environmental and cultural compliance complete for experimental flows to disadvantage smallmouth bass, should the opportunity to use the tool arise.
- We recommend Reclamation work with FWS, NPS, and other partners to fund research regarding potential biological controls (*e.g.*, suggestions in Loppnow *et al*. 2013) or other means to targe smallmouth bass eggs, fry, and juveniles.
- We recommend Reclamation work with FWS, NPS, AZGFD, and other partners to prevent the introduction of additional aquatic non-native invasive species in the action area.
- We recommend Reclamation work with FWS, NPS, AZGFD, and other partners to conduct research on the methods and scale required to effectively monitor populations of non-native aquatic species, assess their ecological effects, contain their distribution, control, reduce or eradicate their populations, and mitigate their effects on native species.

To inform the FWS of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, we request notification of the implementation of any conservation recommendations.

REINITIATION NOTICE

This concludes formal consultation for the Post-2026 Colorado River Reservoir Operations. As provided in 50 CFR §402.16, reinitiation of consultation is required and shall be requested by the Federal agency or by the FWS, where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (1) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (2) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this biological opinion or written concurrence; or (3) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

In keeping with our trust responsibilities to American Indian Tribes, we encourage you to coordinate with the Bureau of Indian Affairs in the implementation of this consultation. By copy of this biological opinion, we are notifying interested tribes of its completion. We also encourage you to coordinate the review of this project with the AZGFD and Utah Division of Wildlife Resources.

We appreciate the Forest Service's efforts to identify and minimize effects on listed species from this project. Please refer to the consultation number 2026-0053145-S7-001 in future correspondence concerning this project. Should you require further assistance or if you have any questions, please contact me (Heather_Whitlaw@fws.gov), Deborah Williams (Deborah_Williams@fws.gov), or Shaula Hedwall (Shaula_Hedwall@fws.gov).

Sincerely,

Heather Whitlaw

Digitally signed by Heather Whitlaw
Date: 2026.08.13 15:30:56 -07'00'

Heather Whitlaw
Field Supervisor

cc (electronic):

Deputy Regional Director, Bureau of Reclamation – Upper Colorado Region, Salt Lake City, UT
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Manager, Cultural Resources Department, Cocopah Indian Tribe, Somerton, AZ
Director, Tribal Historic Preservation Office, Colorado River Indian Tribes, Parker, AZ
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Director, Aha Makav Cultural Society, Fort Mojave Indian Tribe, Needles, CA
Director, Cultural Resource Management Program, Gila River Indian Community, Sacaton, AZ
Tribal Secretary, Havasupai Tribe, Supai, AZ
Director and Tribal Historic Preservation Officer, Cultural Preservation Office, Hopi Tribe, Kykotsmovi, AZ
Director and Tribal Historic Preservation Officer, Cultural Resources Department, Hualapai Tribe, Peach Springs, AZ
Director, Cultural Affairs Office, Jicarilla Apache Nation, Dulce, NM
Director, Cultural Resources, Kaibab Band of Paiute Indians, Fredonia, AZ
Tribal Executive Secretary, Las Vegas Paiute Tribe, Las Vegas, NV
Tribal Historic Preservation Officer, Moapa Band of Paiute Indians, Moapa, NV
Director and Tribal Historic Preservation Officer, Heritage & Historic Preservation Department, Navajo Nation, Window Rock, AZ
Manager, Cultural Resources, Paiute Indian Tribe of Utah, Cedar City, UT
Tribal Historic Preservation Officer, Historic Preservation, Pasqua Yaqui Tribe, Tucson, AZ
Historic Preservation Officer, Quechan Indian Tribe, Yuma, AZ
Tribal Historic Preservation Officer, Pueblo of Acoma, Acoma, NM
Director and Tribal Historic Preservation Officer, Cultural Resource Enterprise, Pueblo of Zuni, Zuni, NM

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Executive Assistant/Tribal Secretary, San Juan Southern Paiute Tribe, Tuba City, AZ
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Executive Director, Inter Tribal Council of Arizona, Phoenix, AZ
Environmental Protection Officer (Acting), Branch of Environmental Quality Services, Western Regional Office, Bureau of Indian Affairs, Phoenix, AZ

FIGURES AND TABLES

Table 1. Glen Canyon Dam Operational Elements and Sideboards.

Operational Element	Operational Sideboards
Lower Basin Shortage Guidelines	• Up to 3.0 maf to provide protection of critical infrastructure at Hoover Dam in dry hydrologic conditions. • The allocation of shortages will be based on then-current law, including the Consolidated Decree. Water entitlement holders may enter into arrangements on a voluntary basis to share in shortages and in that case, the Secretary will allocate shortages according to those arrangements Distribution based on Lower Basin consensus arrangements if they exist; otherwise based on then-current law. • Consultation with the Basin States will occur if projected Lake Mead elevation <1,000 ft to determine potential additional reductions to Lower Basin water deliveries.
Coordinated Reservoir Operations	• 5.0 maf to 12.0 maf Lake Powell WY releases to provide protection for critical infrastructure at Glen Canyon Dam and sufficiently high releases necessary to prevent spill avoidance releases. • Consultation will occur if projected Lake Powell elevation <3,500 ft to determine potential additional actions.
Storage and Delivery of Conserved System and Non-System Water	• Lake Powell: up to 3.0 maf. • Lake Mead: up to 8.0 maf (supports existing Intentionally Created Surplus, new Intentionally Created Surplus–type program, conservation pools, and exchange mechanisms).
Lower Basin Surplus Guidelines	• Up to 500,000 acre-feet in addition to Flood Control and Quantified Surplus.
Additional Activities Above Lake Powell	• Opportunity for maximum use of Upper Initial Units within their respective RODs to protect critical infrastructure. • Voluntary Upper Basin contributions up to 200,000 ac-ft per year subject to hydrologic conditions.

Table 1. Activities that will occur during the 2-Year Decision Cycle.

Month and Operating Year	Activity
August preceding Year 1 of Operating Guidelines	• Issue Operating Guidelines for upcoming 2 years • Use Annual Operating Plan (AOP) process to set operations for Year 1
April 1 of Year 1	• Reclamation identifies assumptions to be used in the April 24-Month Study
May 1 of Year 1	• Determine final Lake Powell WY release volume for Year 1
August of Year 1	• Use AOP process to set operations for Year 2
October of Year 2	• Reclamation conducts review of current operating guidelines and develops considerations for the next set of 2-year operating guidelines
November of Year 2	• Reclamation presents review and considerations
November–March of Year 2	• Reclamation develops preliminary proposed operating guidelines, applying operational principles and sideboards
March of Year 2	• Reclamation releases preliminary operating guidelines.
April 1 of Year 2	• Reclamation identifies assumptions to be used in the April 24-Month Study
May 1 of Year 2	• Determine final Lake Powell WY release volume for Year 2 • Consensus recommendations on upcoming operating guidelines due
May–June of Year 2	• Reclamation finalizes operational guidelines, performs analysis, performs necessary consultations
June 15 of Year 2	• Reclamation identifies and announces upcoming operating guidelines to be adopted
June of Year 2	• Initial AOP consultation on next year's operations (in accordance with upcoming operating guidelines)
July of Year 2	• Reclamation conducts compliance checks on upcoming operating guidelines
August 1 of Year 2	• Issue *Federal Register* Notice with upcoming operating guidelines
August 15 of Year 2	• Use AOP process to set operations for Year 3

Table 3. Potential Initial Water Year Releases by Lake Powell Pool Elevation, 2027-2028 Operating Guidelines

Lake Powell October 1 Pool Elevation (ft)	Potential Initial Lake Powell Water Year Releases (maf)
>3,565	8.23, 8.0, and 7.5
3,566 to 3,540	8.0, 7.5, and 7.0
<3,540	7.0

Table 4. Estimated Monthly Release and Minimum, Average, and Maximum Daily Release Values by Month for each Water Year Release Category.

	5 maf Annual Release		6 maf Annual Release	
Month	**Monthly (kaf)***	**Daily Minimum/Average/Maximum (cfs)**	**Monthly (kaf)***	**Daily Minimum/Average/Maximum (cfs)**
October	403	5,000 / 6,554 / 8,108	410	5,000 / 6,668 / 8,336
November	397	5,000 / 6,672 / 8,344	430	5,000 / 7,226 / 9,161
December	425	5,000 / 6,912 / 8,824	510	5,000 / 8,294 / 10,589
January	438	5,000 / 7,123 / 9,094	570	5,000 / 9,270 / 11,835
February	392	5,000 / 7,058 / 8,822	500	5,000 / 9,003 / 11,253
March	429	5,000 / 6,977 / 8,908	530	5,000 / 8,620 / 11,005
April	406	5,000 / 6,823 / 8,646	470	5,000 / 7,899 / 10,014
May	416	5,000 / 6,766 / 8,531	470	5,000 / 7,644 / 9,759
June	412	5,000 / 6,924 / 8,848	500	5,000 / 8,403 / 10,903
July	436	5,000 / 7,091 / 9,182	560	5,000 / 9,108 / 11,908
August	444	5,000 / 7,221 / 9,441	600	5,000 / 9,758 / 12,758
September	402	5,000 / 6,756 / 8,512	450	5,000 / 7,563 / 9,588

Table 5. Conservation Measures from the LTEMP Biological Opinion (USFWS 2016a) and Near-Term Colorado River Operations Final Supplemental EIS Biological Opinion (USFWS 2024). These are all measures currently implemented by Reclamation and are part of the proposed action. All citations in the conservation measures can be found in the original biological opinions.

Biological Opinion	Beneficiary of Conservation Measure	Conservation Measure
LTEMP	Humpback Chub	• Reclamation would continue to support the NPS, USFWS, Grand Canyon Monitoring and Research Center (GCMRC), and Glen Canyon Dam Adaptive Management Program (GCDAMP) in funding and implementing translocations of humpback chub into tributaries of the Colorado River in Marble and Grand Canyons, and in monitoring the results of these translocations, consistent with agencies' plans and guidance (*e.g.*, NPS Comprehensive Fisheries Management Plan [CFMP], USFWS Humpback Chub Genetics Management Plan and Translocation Framework, and GCMRC Triennial Work Plan). Translocations allow for opportunities to expand the area occupied by humpback chub and improve the overall status of the species. Specifically, the following would occur: o Humpback chub would be translocated from the lower reaches of the LCR to areas above Chute Falls to increase growth rates and survivorship. o Monitoring would be conducted annually, or as needed, depending on the data required, to determine survivability, population status, or genetic integrity of the Havasu Creek humpback chub population. Intermittent translocations of additional humpback chub in Havasu Creek would be conducted if the USFWS and NPS determine it is necessary to maintain genetic integrity of the population. • Reclamation would continue to fund a spring and fall population estimate annually, or at a different frequency as deemed appropriate in consultation with USFWS, using a mark-recapture based model for the LCR or the most appropriate model developed for the current collecting techniques and data. Monitoring the chub population allows us to determine its status (whether it is stable, increasing, or decreasing). • Reclamation would continue to fund control or removal of non-native fish in tributaries prior to chub translocations depending on the existing fish community in each tributary. Reclamation, NPS, and USFWS would lead any investigation into the possibility of using a chemical piscicide, or other tools, as appropriate. Tributaries and the appropriate control methods would be identified by the USFWS, NPS, Reclamation, and GCMRC, in consultation with the Arizona Game and Fish Department (AZGFD). Depending on the removal methods identified, additional planning and compliance may be necessary. Removal of non-native fishes improves the status of chub and other native fishes by reducing competition and predation. The regulation and control of non-native fish is a management action identified in the Humpback Chub Recovery Goals (USFWS 2002a) and Razorback Sucker Recovery Goals (USFWS 2002b). • Reclamation would continue to fund the USFWS in maintenance of a humpback chub refuge population at a federal hatchery (Reclamation has assisted the USFWS in creating a humpback chub refuge at the Southwestern Native Aquatic Resources and Recovery Center [SNARRC]) or other appropriate facility by providing funding

Biological Opinion	Beneficiary of Conservation Measure	Conservation Measure
		to assist in annual maintenance (including the collection of additional humpback chub from the LCR for this purpose). In the unlikely event of a catastrophic loss of the Grand Canyon population of humpback chub, the refuge would provide a permanent source of sufficient numbers of genetically representative stock for repatriating the species. • Reclamation would continue to assist the USFWS, NPS, and GCDAMP to ensure that a stable or upward trend of humpback chub mainstem aggregations can be achieved by: o Continuing to conduct annual monitoring of the LCR humpback chub aggregation (e.g., juvenile chub monitoring parameters). Periodically, an open or multistate model should be run to estimate abundance of the entire LCR aggregation inclusive of mainstem fish. ▪ Supporting annual monitoring in the mainstem Colorado River to determine status and trends of humpback chub and continuing to investigate sampling and analytical methods to estimate abundance of chub in the mainstem. ▪ Conducting periodic surveys to identify additional aggregations and individual humpback chub. o Evaluating existing aggregations and determining drivers of these aggregations, for example, recruitment, natal origins, spawning locations, and spawning habitat (*e.g.*, consider new and innovative methods such as telemetry or the Judas-fish approach) (Kegerries *et al*. 2015). o Exploring means of expanding humpback chub populations outside of the LCR Inflow aggregation. Evaluate the feasibility of mainstem augmentation of humpback chub that would include larval collection, rearing, and release into the mainstem at suitable areas outside of or within existing aggregations. • Reclamation would, through GCDAMP, conduct disease and parasite monitoring in humpback chub and other fishes in the mainstem Colorado. The GCMRC is currently conducting parasite monitoring in the LCR. However, to better understand how/if disease and parasites (primarily Asian tapeworm) are affecting chub and how temperature differences may affect parasite occurrence, this work would be expanded to include investigations of parasites in humpback chub (and surrogate fish if necessary) in the mainstem. Ensuring adequate protection from diseases and parasites is an identified management action needed in the Humpback Chub Recovery Goals (USFWS 2002a) and Razorback Sucker Recovery Goals (USFWS 2002b). • Reclamation would collaborate with the USFWS, GCMRC, NPS, and the Havasupai Tribe to conduct preliminary surveys and a feasibility study for translocation of humpback chub into Upper Havasu Creek (above Beaver Falls). The implementation of surveys and translocations, following the feasibility study, would be dependent on interagency discussions, planning and compliance, and resulting outcomes of Tribal consultation. As stated above, translocations of chub into currently unoccupied habitat aid in expanding the area occupied by the species. In addition, using a tributary to the Colorado River, such as Upper Havasu Creek, protects

Biological Opinion	Beneficiary of Conservation Measure	Conservation Measure
		translocated fish from the effects of dam operations in the mainstem, but still allow for chub in Havasu Creek to contribute to the mainstem population. • Reclamation would, in cooperation with the USFWS, NPS, GCMRC, and AZGFD, explore and evaluate other tributaries for potential translocations.
LTEMP	Razorback Sucker	• Reclamation would continue to assist the NPS, USFWS, and the GCDAMP in funding larval and small-bodied fish monitoring to: o Determine the extent of hybridization in flannelmouth and razorback sucker collected in the western Grand Canyon. o Determine habitat use and distribution of different life stages of razorback sucker to assist in future management of flows that may help conserve the species. Sensitive habitats to flow fluctuations could be identified and prioritized for monitoring. • Assess the effects of Trout Management Flows (TMFs) and other dam operations on razorback sucker.
LTEMP	All Native Aquatic Species	• Reclamation, in collaboration with the NPS and USFWS, and in consultation with the AZGFD, would investigate the possibility of renovating Bright Angel and Shinumo Creeks with chemical piscicide, or other tools, as appropriate. Additional planning and compliance, and Tribal consultation under Section 106 of the National Historic Preservation Act (NHPA), would be required. This feasibility study is outlined in the NPS CFMP (2013; see "Feasibility Study for Use of Chemical Fish Control Methods"). The proposed action benefits humpback chub and other native fish by removing non-native fish that can predate upon and compete with humpback chub. The regulation and control of non-native invasive fish is a management action identified in the Humpback Chub Recovery Goals (USFWS 2002a) and Razorback Sucker Recovery Goals (USFWS 2002b). • Reclamation would continue to fund efforts of the GCMRC and NPS to remove brown trout (and other non-native species) from Bright Angel Creek and the Bright Angel Creek Inflow reach of the Colorado River, and from other areas where new or expanded spawning populations develop, consistent with the NPS CFMP. After 5 years of removal efforts are completed (in 2017), an analysis of success would be conducted. Piscicides may be considered for removal of non-native species if determined to be appropriate and following completion of the necessary planning and compliance actions. The regulation and control of non-native fish is a management action identified in the Humpback Chub Recovery Goals (USFWS 2002a) and Razorback Sucker Recovery Goals (USFWS 2002b). • Reclamation would explore the efficacy of a temperature control device at the dam to respond to potential extremes in hydrological conditions due to climate conditions that could result in non-native fish establishment. Evaluations would be ongoing for all current and evolving technological advances that could provide for warming and cooling the river in both high- and low-flow discharge scenarios, and high and low reservoir levels. These studies should include evaluating and pursuing new technologies, an analysis of feasibility, and a risk assessment and cost analysis for any potential solutions. The regulation and control of non-native fish is a

Biological Opinion	Beneficiary of Conservation Measure	Conservation Measure
		management action identified in the Humpback Chub Recovery Goals (USFWS 2002a) and Razorback Sucker Recovery Goals (USFWS 2002b). • Reclamation would pursue means of preventing the passage of deleterious invasive non-native fish through Glen Canyon Dam. Because Glen Canyon Dam release temperatures are expected to be warmer under low reservoir elevations that may occur through the LTEMP period, options to hinder expansion of warm water non-native fishes into Glen and Grand Canyons would be evaluated. Potential options to minimize or eliminate passage through the turbine or bypass intakes or minimize survival of non-native fish that pass through the dam would be assessed (flows, provide cold water, other). While feasible options may not currently exist, technology may be developed during the LTEMP period that could help achieve this goal. The regulation and control of non-native fish is a management action identified in the Humpback Chub Recovery Goals (USFWS 2002a) and Razorback Sucker Recovery Goals (USFWS 2002b). • Reclamation would, in consultation with the USFWS and AZGFD, fund the NPS and GCMRC on the completion of planning and compliance to alter the backwater slough at River Mile (RM) 12 (commonly referred to as "Upper Slough"), making it unsuitable or inaccessible to warm water non-native species that can compete with and predate upon native fish, including humpback chub. Depending on the outcome of NPS planning and compliance, Reclamation would implement the plan in coordination with the USFWS, AZGFD, NPS and GCMRC. Additional coordination would be conducted to determine and access any habitats that may support warm water non-natives. The regulation and control of non-native fish is a management action identified in the Humpback Chub Recovery Goals (USFWS 2002a) and Razorback Sucker Recovery Goals (USFWS 2002b). As of 2025, the upper slough has been restored into a side channel, improving water flow through the area. However, low dam releases initiated in 2026 may require additional deepening to ensure effective temperature mixing at low flows. • Reclamation would support the GCMRC and NPS in consultation with the USFWS and AZGFD on the completion of planning and compliance of a plan for implementing rapid response control efforts for newly establishing or existing deleterious invasive non-native species within and contiguous to the action area. Control efforts may include chemical, mechanical, or physical methods. While feasible options may not currently exist, new technology or innovative methods may be developed in the LTEMP period that could help achieve this goal. Rapid response to new warm water fish invasions may become a more frequent need in the future with lower reservoir elevations and warmer dam releases. The regulation and control of non-native fish is a management action identified in the Humpback Chub Recovery Goals (USFWS 2002a) and Razorback Sucker Recovery Goals (USFWS 2002b). • Reclamation, will consider, in consultation with the GCDAMP, the experimental use of TMFs to inhibit brown trout spawning and recruitment in Glen Canyon, or other mainstem locations. Inhibiting brown trout spawning and recruitment will benefit chub by reducing the potential for brown trout to predate upon humpback chub. The

Biological Opinion	Beneficiary of Conservation Measure	Conservation Measure
		regulation and control of non-native fish is a management action identified in the Humpback Chub Recovery Goals (USFWS 2002a) and Razorback Sucker Recovery Goals (USFWS 2002b).
Near-Term Colorado River Operations Final Supplemental EIS	Humpback Chub and Razorback Sucker	• Reclamation will design and implement a study to evaluate fish entrainment through Glen Canyon Dam. o An evaluation of fish entrainment could provide details to improve predictive models that indicate propagule pressure of smallmouth bass or other non-native species at different Lake Powell elevations (Eppehimer *et al*. 2025). Further, analysis of fish passthrough can provide a better understanding of fish assemblages, water temperature, and other aspects of water quality that pass through the dam into the Colorado River below Glen Canyon Dam. The result of this study will help Reclamation and the NPS identify, manage, and minimize threats from non-native fish from Lake Powell in the Colorado River below Glen Canyon Dam. • Reclamation will support an annual monitoring of backwaters and other low-velocity habitats for non-native fishes. o Backwater and low-velocity habitats may be the first habitats to be invaded by warm water non-native species of fish. Further, these locations are high value habitats to young humpback chub and razorback sucker. Thus, additional evaluation of these habitats during stress events associated with lower water will provide critical data on current distribution and overlap between species such as smallmouth bass and humpback chub (Smallmouth Bass Ad Hoc Group 2023). • Reclamation will pursue the potential to manipulate flows to reduce the temperature to benefit Humpback Chub and disadvantage warm water species. o Reducing the temperature in the mainstem of the Colorado River below Glen Canyon Dam is expected to have a beneficial effect on Humpback Chub by limiting the numbers of warm water non-native species such as smallmouth bass. Flow manipulations that require the use of bypass tubes or outlet works from the dam could pull cooler water into the outflow and reduce the water temperature below the dam thereby limiting smallmouth bass spawning and growth (Yackulic et al. 2024). Flow manipulations that dewater habitat for smallmouth bass by releasing less water from the hydropower generating tubes could disrupt nesting (Bestgen et al. 2026). • Reclamation's Upper Colorado Regional Office and the LCR MSCP will coordinate on and fund efforts to better understand movements of non-native species from below Pearce Ferry Rapid into the Grand Canyon. o Pearce Ferry Rapid is considered a partial barrier to the movement of fish between Lake Mead and the western Grand Canyon. Historically, predatory fish from Lake Mead (e.g., Striped Bass) would move into the western Grand Canyon but may have been recently limited by the rapid which occurs above the inflow/delta at Lake Mead. Evaluating this region and the fish passage through it will allow management agencies to identify future actions that may protect native fish populations from non-native species in Lake Mead.

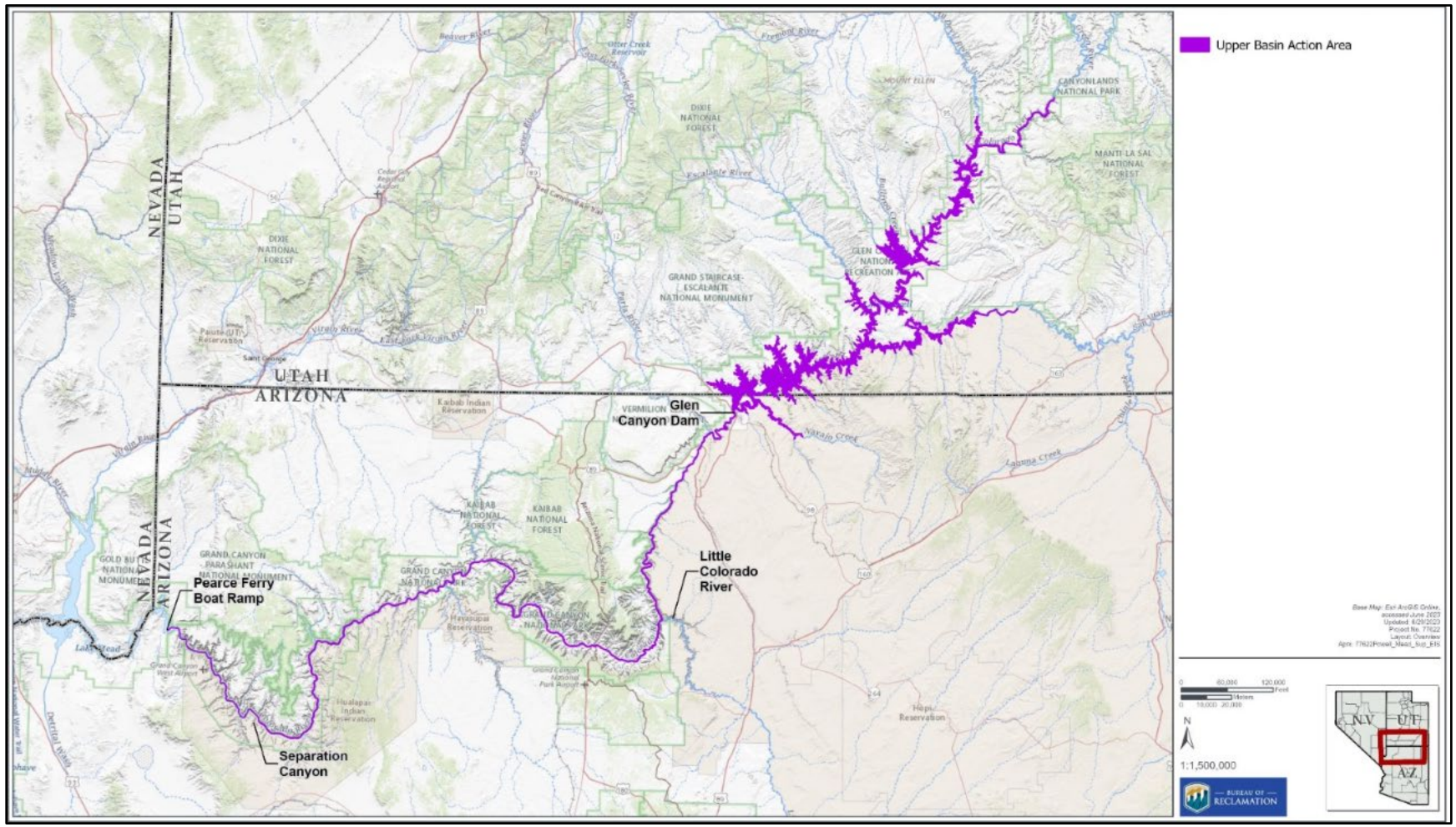
Biological Opinion	Beneficiary of Conservation Measure	Conservation Measure
		• Reclamation's Upper Colorado Regional Office will convene an expert science panel (that includes representation from the Humpback Chub Recovery Team and management agencies) to determine which Humpback Chub population dynamics in the western Grand Canyon population should trigger conservation interventions to prevent population decline. The panel's responsibility would be to evaluate population dynamics in this reach and recommend conservation intervention measures that might be undertaken. This process could be similar to and follow the management triggers plan developed for the LCR population of Humpback Chub for the LTEMP BO (U.S. Fish and Wildlife Service 2016). This plan would be developed prior to the post-2026 plan for Glen Canyon Dam operations so as to consider these intervention measures for inclusion in that plan.

Table 6. Annual Outflow, Smallmouth Bass Entrainment, and Downstream Smallmouth Bass Population Growth Estimates for Lake Powell Elevation Categories.

Average annual elevation is calculated as the end of month elevations, averaged across a calendar year. This differs slightly from the Eppehimer *et al*. (2025) model which uses "starting water year elevation," rather than "average annual elevation" but 3,565 feet is the critical elevation allowing smallmouth bass entrainment in both analyses. The minimum number of entrained fish possible in a year in the Eppehimer *et al*. (2025) model is six fish, which reflects the potential for smallmouth bass to use even the deepest parts of the lake water column. The minimum smallmouth bass population growth possible in the Eppehimer *et al*. (2025) model is 0.8, which reflects the natural mortality of adult fish. Population growth rate is defined by lambda (λ). λ >1 indicates a positive population growth rate (increasing population size) while λ <1 indicates a negative growth rate (decreasing population size).

Average Annual Powell Elevation (feet)	**Variable**	**Minimum**	**Median**	**Average**	**Maximum**
3,565–3,700	Annual Outflow (maf)	6.4	8.3	9.4	30.5
	Entrainment (number of fish)	6.0	6.0	8.8	244.0
	Bass population growth (lambda [λ])	0.80	0.80	0.80	0.80
3,540–3,565	Annual Outflow (maf)	6.0	7.1	7.1	8.1
	Entrainment (number of fish)	8.0	21.0	44.2	274.0
	Smallmouth Bass Population Growth (λ)	0.80	0.80	0.88	1.10
3,490–3,540	Annual Outflow (maf)	4.8	6.0	6.1	7.8
	Entrainment (number of fish)	22.0	160.0	203.9	605.0
	Smallmouth Bass Population Growth (λ)	1.00	1.40	1.41	1.70

Figure 1. Map of the Action Area.



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APPENDIX A: CONCURRENCES

This appendix contains our concurrence with your "may affect, not likely to adversely affect" determinations for the bonytail (*Gila elegans*), Colorado pikeminnow (*Ptychocheilus lucius*; pikeminnow) and its designated critical habitat, southwestern willow flycatcher (*Empidonax traillii extimus*; flycatcher), and western yellow-billed cuckoo (*Coccyzus americanus*; cuckoo).

Bonytail

We concur with your determination that the proposed action "may affect but is not likely to adversely affect" the bonytail, for the following reasons:

- Bonytail has been extirpated downstream of Glen Canyon Dam to Pearce Ferry within the action area since the 1940s. In 2022, the Utah Division of Wildlife Resources stocked bonytail at Wahweap State Fish Hatcher because they had an excess of fish at the hatchery. In the summer of 2023, two bonytail were captured below Glen Canyon Dam (DOI 2026a). Although these fish were likely entrained through Glen Canyon Dam following stocking, it is extremely unlikely that additional bonytail will occur below Glen Canyon Dam. Rapid response efforts to remove invasive warm water species as well as other monitoring efforts conduct regular monitoring and these surveys have not detected any other bonytail. Therefore, the effects of the Proposed Action are discountable.
- Data from the Upper Basin shows low survival by stocked bonytail, and there are no reports of successful spawning and recruitment in the Upper Basin. Because it is extremely unlikely that bonytail occur in the action area above Glen Canyon Dam, the effects of the proposed action are discountable.

Colorado Pikeminnow and Critical Habitat

We concur with your determination that the proposed action "may affect but is not likely to adversely affect" the pikeminnow, for the following reasons:

- Pikeminnow are extirpated from the Colorado River downstream of Glen Canyon Dam. Therefore, the Proposed Action will not affect pikeminnow below Glen Canyon Dam.

- Pikeminnow are expected to benefit from lower Lake Powell elevations that will provide more exposed river habitat in the Colorado River and San Juan River inflows. The lower lake elevations will also allow the Piute Farms waterfall to persist and block upstream movement of non-native fish from Lake Powell into the San Juan River. Therefore, we expect the Proposed Action will have insignificant effects on pikeminnow above Glen Canyon Dan.

- Pikeminnow designated critical habitat extends into the Colorado River and San Juan River inflows of Lake Powell. The Proposed Action will result in insignificant effects on the PBFs of water, biological environment, and physical habitat.

Southwestern Willow Flycatcher

We concur with your determination that the proposed action "may affect, but is not likely to adversely affect" the flycatcher, for the following reasons:

- The action area may provide flycatcher breeding habitat at the downstream end of the action area based on recent pair detections in 2023 at RM 260 and RM 275. NPS surveyed both sites in 2025 with no detections. This area is at the downstream end of the action area; therefore, daily flow fluctuations from lower-volume releases are extremely unlikely to affect potential breeding habitat because effects diminish downstream as flow waves attenuate. Therefore, the proposed action will have discountable effects on breeding flycatchers and potential breeding habitat.
- Flycatchers may use riparian vegetation in the action area for short-term for foraging and during migration. Because of the temporary nature of changes in mainstem flows on existing riparian vegetation, we expect the proposed action will have insignificant effects on foraging and/or migrating flycatchers.

Western Yellow-billed Cuckoo

We concur with your determination that the proposed action "may affect, but is not likely to adversely affect" the cuckoo, for the following reasons:

- The action area does not provide cuckoo breeding habitat. Therefore, the proposed action will have discountable effects on breeding cuckoos because it is extremely unlikely that breeding cuckoos use the action area.
- Cuckoos may use riparian vegetation in the action area for short-term for foraging and during migration. Because of the temporary nature of changes in mainstem flows on existing riparian and woodland vegetation, we expect the proposed action will have insignificant effects on foraging and/or migrating cuckoos.