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In reply refer to:

AESO/SE

02EAAZ00-2012-F-0059

02EAAZ00-2014-CPA-0029

Memorandum

To: Wayne Pullan, Regional Director, Program Manager, Bureau of Reclamation, 125 South State Street, Salt Lake City, UT 84138-1102

From: Field Supervisor

JEFFREY
HUMPHREY

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JEFFREY HUMPHREY
Date: 2021.06.08
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Subject: Report on the 2016 Biological Opinion for Glen Canyon Dam Long-Term Experimental and Management Plan: Compliance Summary and Conservation Measure Progress, Fiscal Year (FY) 2020

Dear Mr. Pullan:

Thank you for the Bureau of Reclamation's (Reclamation) annual summary of progress of the implementation of the Glen Canyon Dam Long-Term Experimental and Management Plan (LTEMP) and progress towards the associated Biological Opinion (BO). This responds to your memorandum requesting review by the U.S. Fish and Wildlife Service (Service) of the summary of LTEMP activities related to listed species under the care of the program. In your summary you included; Report on the LTEMP BO Compliance Summary and Conservation Measure Progress for FY 2020, and associated reports for that time period. This report helps inform LTEMP management for the following year and ensures that impacts to listed species, and their habitats are within the reasonable bounds outlined in the BO.

We have reviewed the materials provided and conclude that the actions of Reclamation meet the requirements of the BO and acknowledge the program made sufficient progress in FY 2020. All covered actions and implementation of the conservation measures are suitably described and documented. Reclamation is a strong partner for conservation in the Lower Colorado River Basin, and we commend the program's contribution.

On January 6, 2021, Reclamation informed the Service that one of the humpback chub management triggers, associated with the incidental take parameters, described in the 2016 LTEMP BO may have been exceeded. The 3-year average (2018-2020) of juvenile humpback

chub in the Colorado River mainstem from river mile 63.45 to 65.2 (juvenile chub monitoring reach) was estimated at 600 fish, which is below the 810 fish required to prevent initiation of a Tier 1 trigger. The Tier 1 trigger response consists of expanded conservation actions to prevent further decline in humpback chub populations. These actions are intended as early intervention and to avoid the need for more invasive mechanical removal of non-native predacious fish that feed on humpback chub. Although a Tier 1 trigger has been met, exceedance of the overall incidental take of humpback chub under the LTEMP BO has not occurred at this time. Reclamation staff are working in close coordination with the Service to consider appropriate response options consistent with the LTEMP BO. The team has identified factors that may have led to poor recruitment, assessed the current outlook for humpback chub populations in the Grand Canyon, and evaluated early intervention alternatives. Reclamation is working in good faith with the Service to meet the requirements of the LTEMP BO and avoid exceedance of take parameters for humpback chub.

We appreciate the positive working relationship between staff of the Service and Reclamation on the implementation of the LTEMP. The opportunity to collaborate with staff in the compiling of this report and LTEMP activities are valued. Thank you for your significant efforts to conserve listed and special-status species through the LTEMP.

If there are any questions or concerns about this response, please contact Jessica, or me at (602) 242-0210.

cc (electronic):
Lee Traynham
Kirk Young



— BUREAU OF —
RECLAMATION

LTEMP Biological Opinion – Progress Report on Compliance & Conservation Measures



Photo Credit: K. Pedersen, Reclamation

Fiscal Year 2020

LTEMP Compliance Summary

This report serves to summarize the Bureau of Reclamation's (Reclamation) evaluation of progress regarding implementation of the U.S. Fish and Wildlife Service's (FWS) 2016 Biological Opinion for the Glen Canyon Dam Long-Term Experimental and Management Plan (2016 LTEMP BO) for fiscal year 2020. Reclamation has reviewed the reporting requirements of the 2016 LTEMP BO and offers this summary report, which reviews the status of listed species in the action area, describes progress on implementation of conservation measures, and assesses levels of incidental take. On January 22, 2020 the humpback chub was proposed for downlisting from endangered to threatened, and the kanab ambersnail was proposed for removal from the federal list of endangered and threatened species on January 6, 2020. These proposed reclassifications have not affected the work reported here. As supporting documentation to the summary report, we have also attached the final project reports of those projects that support implementation of the 2016 LTEMP BO conservation measures.

Incidental Take Summary for Fiscal Years (FY) 2018 – 2020

The measures described in the Incidental Take Statement of the 2016 LTEMP BO are non-discretionary and must be undertaken by Reclamation when triggered. To monitor the impact of incidental take, Reclamation must report the progress of the action and its impact on the species to the FWS as specified in the incidental take statement.

Humpback Chub

The tables below summarize data from the past three years to determine whether Tier 1 (early intervention) or Tier 2 (threat reduction) actions required by the 2016 LTEMP BO have been, or may be, triggered to prevent exceeding incidental take. Under Tier 1 parameters, early intervention action is required if the combined point estimate for adult humpback chub (HBC; adults defined as ≥ 200 mm total length) in the Colorado River mainstem and Little Colorado River (LCR aggregation) falls below 9,000. Similarly, early intervention action is required if recruitment of sub-adult HBC does not equal or exceed adult mortality. Early intervention consists of conservation actions such as expanded translocation efforts. As shown in Table 1, the point estimate for the number of adults and the three-year average population and recruitment estimates for the sub-adult spring estimate of the LCR population are above levels that would require Tier 1 action. However, the three-year average of the sub-adult fall estimate is below the 810 required, thus triggering Tier 1 early intervention actions (see Mark-Recapture & Fish Monitoring Activities in the LCR in Grand Canyon 2000-2020).

Under Tier 2 parameters, threat reduction actions are required if the combined point estimate for adult HBC in the Colorado River mainstem and Little Colorado River (LCR aggregation) falls below 7,000. Threat reduction actions consist of mechanical removal of nonnative aquatic predators from the LCR aggregation reach and immediate vicinity. Table 2 summarizes the conditions under which Tier 2 actions would be terminated, either by reducing the predator index or by increasing HBC population and recruitment levels.

Table 1. Tier 1 thresholds that trigger additional conservation actions for humpback chub (HBC)

TIER 1 Early Intervention	# of HBC that triggers an action	ESTIMATED # of HBC			
		2018	2019	2020	3-year average
1. Combined adult (≥ 200 mm) HBC mainstem Little Colorado River (LCR) aggregation ($\geq 2,000$) and juvenile HBC in LCR ($\geq 7,000$)	$\leq 9,000$	15,000	12,000	11,000	
OR					
2. Recruitment of sub-adult (150-199 mm) HBC does not equal or exceed estimated adult mortality					
A. Sub-adult population estimate in LCR in spring	$\leq 1,250$ for 3 years	1,800	2,600	1,000	1,800
OR					
B. Sub-adult population estimates in mainstem in JCM Reach* in fall	≤ 810 for 3 years	1,100	500	200	600

*Juvenile Chub Monitoring Reach is RM 63.45-65.2 of the mainstem.

Table 2. ** Tier 2 triggers that terminate mechanical removal of non-native fish to protect humpback chub

TIER 2 Mechanical Removal	Action Termination Trigger	Observed	
		2019	2020
Nonnative Aquatic Predator index	< 60 rainbow trout / km	--	--
Immigration rate	Low (to be determined)	--	--
HBC population estimates	> 7,500	--	--
Survival rates of sub-adult chub	Exceeds adult mortality for at least 2 years	--	--

**This table remains blank unless the number of adult humpback chub < 7,000, which indicates mechanical removal is required. This table outlines the conditions necessary to terminate the action.

Razorback sucker

The incidental take of razorback suckers is considered to be exceeded if actions associated with LTEMP base operations and experimental flows result in a statistically significant decline (95% confidence intervals) in mean catch per unit effort (CPUE) of adult flannelmouth suckers for a consecutive 3-year period following the occurrence of experimental flows. Because razorback suckers are extremely rare in the project area and it is impossible to distinguish larval razorback

suckers from flannelmouth suckers in the field, flannelmouth suckers are identified as a surrogate for incidental take of razorback suckers in the 2016 Biological Opinion. The most recent experimental flows that occurred were a fall High Flow Experiment (HFE) in November 2018, and macroinvertebrate production flows (bug flows) in 2018, 2019, and 2020.

CPUE data is collected by Arizona Game & Fish Department (AGFD) in lower Grand Canyon in spring and fall where flannelmouth suckers overlap with known locations of larval razorback suckers (approximately from RM 179.1 to RM 225 [AGFD sampling Reach 5] and >RM 225 [AGFD sampling Reach 6]).

Table 3. Catch per unit effort (fish/hour) with 95% confidence intervals of adult flannelmouth suckers (>325 mm total length) in lower Grand Canyon (RM>179) by capture method.

Method	2019	2020	2021	3-year average
Electrofishing	3.7342 (2.5867-4.8817)	3.8846 (1.6829-6.0862)		
Hoop net	0.0829 (0.0446-0.1213)	0.0568 (0.0280-0.0856)		

Conservation Measure Progress, FY 2020

HUMPBACK CHUB

Ongoing Actions:

- 1) Reclamation would continue to support the NPS, FWS, U.S. Geological Survey’s (Survey) Grand Canyon Monitoring and Research Center (GCMRC), and 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], FWS Humpback Chub Genetics Management Plan and Translocation Framework, and GCMRC Triennial Work Plan). Specifically, the following would occur:
 - i. Humpback chub would be translocated from the lower reaches of the Little Colorado River (LCR) to areas upstream of Chute Falls to increase growth rates and survivorship.

Efforts to translocate HBC upstream of Chute Falls in the LCR have been ongoing since 2003 with 4,142 juvenile (~80-130 mm TL) HBC translocated to date. Of these, 364 were released above Chute Falls (at river kilometer [RKM] 16.2) on October 23, 2020.

FWS conducts an annual trip to monitor the abundance of HBC translocated upstream of Chute Falls (RKM 13.6) and in the “Atomizer reach,” (RKM 13.6 - 14.1). This effort typically occurs in May or June, when there is no danger of flooding, and it is safe to conduct activities in this stretch of river. Because of COVID-19 concerns in May, and a lack of flooding later in the summer, this effort was conducted in October 2020. (see 2020 GCMRC Annual Report for Project Element G.7, Chute Falls Translocations).

- ii. 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 FWS and NPS determine it is necessary to maintain genetic integrity of the population.

NPS conducted one monitoring trip to Havasu Creek in October 2019. Monitoring was limited to ensure employee safety during the COVID-19 pandemic. In October 2019, 97 HBC were captured during single-pass netting. Of these, 65 were non-translocated fish. While the age-1 juvenile humpback chub cohort was rare, multiple age-classes of humpback chub were observed, including many untagged and sexually mature fish presumably produced *in situ*. HBC captures included 18 young-of-year (YOY). Despite the appearance of a weak year class in 2018, multiple age-classes of humpback chub continue to be observed, including YOY produced *in situ*.

No HBC were translocated to Havasu Creek in 2020. Translocation efforts were focused on Bright Angel Creek, and monitoring was conducted in Havasu Creek to better understand the population dynamics.

- 2) Reclamation would continue to fund a spring and fall population estimate annually, using a mark-recapture based model for the Little Colorado River or the most appropriate model developed for the current collecting techniques and data.

In 2020, FWS and volunteers conducted monitoring trips in September and October to monitor the population status and trends of humpback chub in the LCR. Due to COVID-19, the usual monitoring trips in April and May were cancelled, and as a result, the spring 2019 estimates were used to calculate an estimate for spring 2020. See Table 4 for the estimates of HBC by sampling period

(see **Mark-Recapture & Fish Monitoring Activities in the LCR in Grand Canyon 2000-2020**).

Table 4. The estimates of humpback chub (HBC) by size (total length (TL)) with standard errors (SE) for each sampling period.

Sampling Timeframe	# of HBC TL >150 mm ± SE	# of HBC TL ≥200 mm ± SE
Spring 2019	11,210 (9,910-12,500)	8,987 (7,939-10,035)
Fall 2020	5,383 (5,108-5,658)	1,941 (1,781-2,101)

- 3) Reclamation would continue to fund control or removal of nonnative fish in tributaries prior to chub translocations depending on the existing fish community in each tributary. Reclamation, NPS, and FWS 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 FWS, NPS, Reclamation, and GCMRC, in consultation with AGFD. Depending on the removal methods identified, additional planning and compliance may be necessary.

In 2020, NPS operated a weir at the confluence of Bright Angel Creek from October through February; 4 brown trout and 7 rainbow trout were removed. Electrofishing was also conducted in Bright Angel Creek and other tributaries from October through January yielding removal of 312 brown trout and 1,001 rainbow trout (see 2019-2020 Bright Angel Creek Brown Trout Control Season Report). Trends in native fish and nonnative trout in Bright Angel Creek were published in Healy et al. 2020a.

- 4) Reclamation would continue to fund the FWS in maintenance of a humpback chub refuge population at a federal hatchery (Reclamation has assisted the FWS in creating a humpback chub refuge at the Southwestern Native Aquatic Resources and Recovery Center [SNARRC]) or other appropriate facility by providing funding to assist in annual maintenance (including the collection of additional humpback chub from the Little Colorado River 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.

In 2020, the spring collection trip was cancelled due to COVID-19. However, the humpback chub that were translocated to Bright Angel creek in June were originally collected from the LCR in 2019 and were reared at SNARRC until they were translocated.

5) Reclamation would continue to assist the FWS, NPS and the GCDAMP to ensure that a stable or upward trend of humpback chub mainstem aggregations can be achieved by:

- i. 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.

In 2020, FWS conducted 4 river trips to monitor HBC in the mainstem Colorado River. Trips in June and July 2020 focused on mark-recapture of HBC in the mainstem several miles upstream of Pearce Ferry between RM 273.9-275.9. These two 6-day trips were conducted in lieu of the spring LCR monitoring trips (cancelled due to COVID-19), and to further understand the abundance of HBC in far western Grand Canyon, particularly where habitat is thought to be less than optimal. From these efforts, it was provisionally estimated there were 200-300 adult HBC (TL \geq 200 mm) per mile in this 2-mile reach of river.

A third trip (the annual HBC aggregation trip) occurred from September 1-18, 2020 between Lees Ferry and Pearce Ferry with the objective of continuing long-term relative abundance (CPUE) index of HBC in known historical aggregation sites. In addition, HBC were marked within four discrete river reaches as part of mark-recapture studies: 1) the JCM-west site near Pumpkin Springs (RM 210.2-213.8), 2) downstream of Diamond Creek between RM 227.2-229.2, 3) below Separation Canyon (RM 239.9-241.9), and 4) between RM 265-267.

A final trip occurred from Diamond Creek down to Pearce Ferry from October 3-8, 2020. This trip functioned as a recapture event for the three previous trips where HBC were marked below Diamond Creek. Baited hoop nets were employed on all trips, and submersible antennas were employed on trips where fish were marked. (see 2020 GCMRC Annual Report for Project Element G.5 & Mark-Recapture & Fish Monitoring Activities in the LCR in Grand Canyon 2000-2020 (FWS)).

- ii. 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.

In 2020, the May JCM-East trip was cancelled due to the COVID-19 pandemic; however, monitoring trips occurred in July and October (Table

5). Slow-shock electrofishing and hoop nets were used to capture fish, and 8 submersible antennas were deployed to supplement electrofishing and hoop netting efforts. All HBC >79 mm TL were marked with PIT-tags, and HBC 40-79 mm TL were marked using visual implant elastomer (VIE). At JCM-East, 895 HBC > 79mm TL and 311 HBC 40-79 mm TL were captured. Sampling near Fall Canyon consisted of three passes of hoop net captures and night-time electrofishing. In the JCM-West reach, 587 HBC >79 mm TL and 104 HBC 40-79 mm TL were captured (2020 GCMRC Annual Report for Project G.3 & Project G.6).

Table 5. The number of juvenile humpback chub of each size identified during mainstem monitoring trips conducted in July and October 2020. The trip planned for May was cancelled due to COVID-19. The table only includes unique fish.

Location	May		July		October		TOTAL	
	40-79 mm	>79 mm	40-79 mm	>79 mm	40-79 mm	>79 mm	40-79 mm	>79 mm
JCM-East	-	-	58	282	253	483	311	765
JCM-West	-	-	66	398	38	161	104	559

- iii. Conducting periodic surveys to identify additional aggregations and individual humpback chub.

HBC specific surveys outside of recognized aggregations is performed every 3rd year. The next survey is scheduled for 2022.

- iv. 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).

Estimates of vital rates and recruitment of HBC in the JCM-West aggregation have been developed. Analyses to improve the understanding of drivers of HBC in this aggregation is continuing but results are not available yet. Telemetry and natal origins work has not yet begun. Preliminary results and an update on progress is available in the GCMRC FY2020 Annual Report, Project G.

- v. Exploring means of expanding humpback chub populations outside of the Little Colorado River 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.

HBC have expanded unaided into the Western Grand Canyon over the last few years. Research and study to better understand the drivers behind this autonomous expansion is ongoing.

The initial intent of this measure was to explore the potential for expansion in areas with suitable thermal characteristics (warm) below Havasu, and this evaluation may be considered in the future.

- 6) Reclamation would, through the GCDAMP, conduct disease and parasite monitoring in humpback chub and other fishes in the mainstem Colorado. The USGS and GCMRC is currently conducting parasite monitoring in the Little Colorado River. However, in order 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.

In 2020, monitoring for Asian fish tapeworm did not occur; due to COVID-19 concerns, access to the Little Colorado River on Navajo Nation lands was restricted. Infestation rates from 2015-2019 indicated relatively low incidence of infestation (average = 20% infestation) with typically only a single worm found per fish, whereas assessments conducted from 2005-2007 averaged 40% infestation, with up to 182 tapeworms found in a single fish. The reason for this apparent recent decline in Asian tapeworm infestation is unknown (see GCMRC FY20 Annual Report Project I).

Table 6. The number of Asian fish tapeworms detected in humpback chub from 2018-2020 at 2 locations in the Grand Canyon.

Year	Boulder's Camp (LCR)		Bridge City (below Diamond Creek)	
	# of HBC sampled	# of HBC with Asian tapeworm	# of HBC sampled	# of HBC with Asian tapeworm
2018	36	6	43	0
2019	43	12	0	0
2020*	0	N/A	0	N/A

*No sampling was conducted in 2020 due to COVID-19.

New Actions:

- 7) Reclamation would collaborate with the FWS, 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.

FWS is leading initial discussions of the feasibility of translocating humpback chub into Upper Havasu Creek and will report back when progress has been made.

- 8) Reclamation would, in cooperation with the FWS, NPS, GCMRC, and AGFD, explore and evaluate other tributaries for potential translocations.

NPS conducted two monitoring trips to Shinumo Creek-Colorado River Inflow and captured 23 humpback chub total (see 2020 NPS Annual Report of Translocation Activities). NPS continues to monitor the recovery of Shinumo Creek to evaluate its potential for future humpback chub translocations. Data reflecting trends in stream habitat (e.g., substrate composition, channel dimensions, etc.), temperature, macroinvertebrates (food base), and native and nonnative fish distribution and abundance pre- and post-flood are in the process of being evaluated and summarized for discussion.

Through a collaboration between Reclamation, Utah State University, and the NPS, an analysis of drivers of the Shinumo and Havasu Creek HBC populations is in progress. Preliminary recruitment, survival, and fidelity rates were estimated for translocated and non-translocated HBC in each location. Following observations of spawning humpback chub in the mouth of Shinumo Creek in 2019, young-of-year fish were captured and released in the same location in 2020. In addition, reproduction and recruitment in Havasu Creek were documented (Healy et al. 2020b).

RAZORBACK SUCKER

Ongoing Actions:

- 1) Reclamation would continue to assist the NPS, FWS, and the GCDAMP in funding larval and small-bodied fish monitoring in order to:

- i. Determine the extent of hybridization in flannelmouth and razorback sucker collected in the western Grand Canyon.

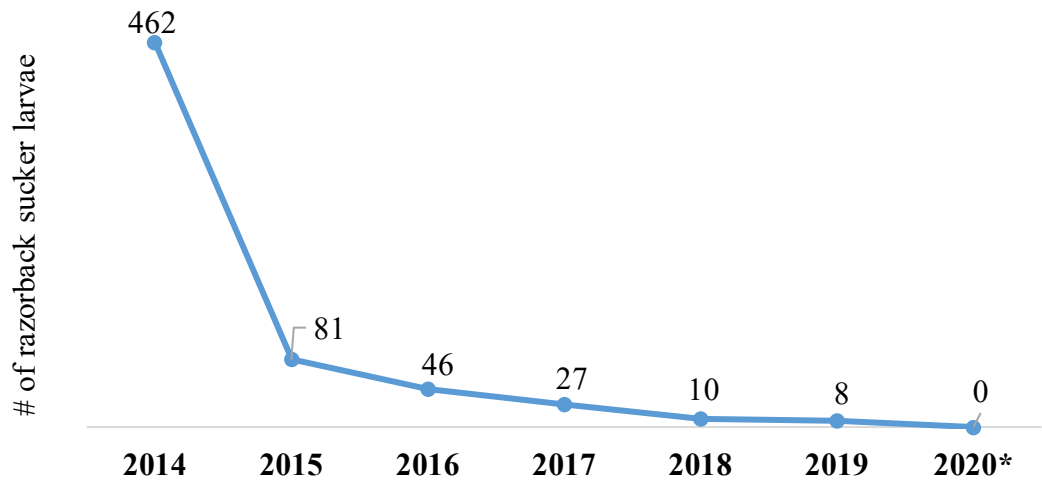
A study to determine genetic hybridization between flannelmouth suckers and razorback suckers is ongoing. Larval fish are collected during river sampling and preserved in alcohol to allow for genetic testing. Samples have been collected and preserved in alcohol since 2019; however the number of larval razorback suckers that have been collected each year has dropped significantly since the first collections of larvae in 2014 (samples collected from 2014-2018 were preserved in formalin which is not conducive to genetic testing). No larval razorback suckers were collected in 2020 upstream of the Pearce Ferry Rapid.

- ii. 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.

For the seventh consecutive year, BioWest conducted monitoring of razorback suckers and other fish on the Colorado River within Grand Canyon National Park. No larval razorback suckers were identified in 2020 (2020 Razorback Sucker Research & Monitoring Annual Report). However, due to COVID-19 the trips that were scheduled for April and May had to be cancelled, and this is the timeframe when larval razorback suckers have been captured in previous years. The number of larval razorback sucker taken per sampling year has continued to decline since the start of this study in 2014 (Figure 1).

Other native and non-native larval and small-bodied fish are identified during collections throughout the Grand Canyon. Since samples are collected over several months and multiple years, the data will help to identify patterns in distribution and abundance of various native and nonnative fish species. The long-term data set might also be useful for making inferences regarding effects of flows and water temperature on various fish species.

Figure 1. The number of razorback sucker larvae identified in the Grand Canyon from 2014-2020.



* No trips occurred in April or May due to COVID-19 restrictions. These are the months when larval razorback suckers have been identified in previous years.

- iii. Assess the effects of Trout Management Flows (TMF) and other dam operations on razorback sucker.

No TMFs have occurred since implementing the 2016 LTEMP, nor have they been scheduled to be tested. On November 5-8, 2018, the Department of the Interior conducted the most recent HFE release from Glen Canyon Dam. The HFE release included a peak flow of approximately 38,100 cubic feet per second for 60 hours (four days including ramping from baseflows to peak release) to move accumulated sediment downstream to help rebuild beaches and sandbars. This HFE release was the first to be conducted under the 2016 LTEMP HFE Protocol.

Baseline data collected in the razorback project described above was used to evaluate the effect of the HFE. The mean annual native fish catch rates did not reveal any significance between discharge and small-bodied native fish catch rates in 2020 compared to previous years indicating the HFE did not significantly impact native fish populations (reported in 2020 Razorback Sucker Research & Monitoring Annual Report, page 50). Due to the low numbers of razorback suckers in the Grand Canyon, the impact specifically on this fish species could not be evaluated. However, the impact is expected to be similar to that of other native fish species. Additional data will be collected during and after future flow experiments to assess the effects on razorback suckers and other native fish species.

ACTIONS TO BENEFIT ALL NATIVE SPECIES

Ongoing Actions:

- 1) Reclamation, in collaboration with the NPS and FWS, and in consultation with the AZGFD, would investigate the possibility of renovating Bright Angel and Shinumo Creeks with a chemical piscicide, or other tools, as appropriate. Additional planning and compliance, and tribal consultation under Section 106 of the NHPA, would be required. This feasibility study is outlined in the NPS CFMP (2013; see “Feasibility Study for Use of Chemical Fish Control Methods”).

NPS continues to monitor the recovery of Shinumo Creek to evaluate its potential for future humpback chub translocations and/or chemical piscicide treatment. Following completion of the NPS Expanded Nonnative Aquatic Species EA and FONSI in 2019, and in cooperation with the AGFD, the NPS began to plan for a future rotenone treatment in the upper reaches of Bright Angel Creek and in Shinumo Creek. The treatment is being planned to remove invasive trout in both areas and to prepare to reinitiate translocations of humpback chub to Shinumo Creek. As stipulated in the programmatic agreement between NPS, Arizona State Historic Preservation Office, and Tribes, additional consultation will be completed during planning for piscicide use.

- 2) Reclamation would continue to fund efforts of the GCMRC and NPS to remove brown trout (and other nonnative 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 nonnative species if determined to be appropriate and following completion of the necessary planning and compliance actions.

From October 3, 2019 through February 20, 2020, a modified resistance board weir with a downstream-orientated fish trap was operated in Bright Angel Creek near its confluence with the Colorado River. For a fifth consecutive season, trout captures in the weir remained low with 4 brown trout and 7 rainbow trout captured at Bright Angel Creek.

Electrofishing was conducted in Bright Angel Creek and other tributaries from October 22, 2019– January 26, 2020 with 312 brown trout and 1,001 rainbow trout removed (2019-2020 Bright Angel Creek Brown Trout Control Season Report).

Stream-wide native fish abundance continued to exceed baseline levels determined in 2012-2013, while total salmonid abundance was ~95% lower compared to 2012-2013 abundance.

Following completion of the NPS Expanded Nonnative Aquatic Species EA and FONSI in 2019 and in cooperation with the AGFD, the NPS began to plan for a future rotenone treatment in the upper reaches of Bright Angel and Shinumo Creeks.

New Actions:

- 3) 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 nonnative 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 the feasibility, and a risk assessment and cost analysis for any potential solutions.

Reclamation's Research and Development Office (based in Denver) completed a report reviewing the temperature control options for reservoir releases in January 2020. A technology search was recommended as a next step to seek industry cross-cutting ideas. In March 2020, Reclamation contracted with the company yet2 to complete a Technology Search to explore innovative water temperature control devices. Reclamation is currently reviewing a summary report to determine whether any options might be applicable to Glen Canyon Dam.

- 4) Reclamation would pursue means of preventing the passage of deleterious invasive nonnative 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 warmwater nonnative 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 nonnative 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.

Reclamation partnered with the Department of Energy Water-Power Technologies Office to launch a prize competition to evaluate fish passage

<https://www.energy.gov/eere/articles/doe-and-bureau-reclamation-collaborate-launch-new->

[fish-protection-prize](#)). The competition was not specific to reservoir intakes and it is possible that some of the submissions may not be useful for Glen Canyon Dam (<https://www.herox.com/FishProtection/entries>).

The prize-winning teams (<https://americanmadechallenges.org/fishprotection/pitch.html>) were selected in September 2020 and included the following:

- **Grand prize: Benjamin Mater of Alden Research Laboratory and Charles Coutant, Making a Deal with the Devilfish: Biometric-Informed Screening Technology**
- **Second place: Nicholas and Kenneth LaBry of Prometheus Innovations, LLC, Fish Diversion Material & Inspection Improvements**
- **Third place: Sterling Watson and Abe Schneider of Natel Energy, The Center Sender.**

Reclamation is currently reviewing a summary report to determine whether any options might be applicable to Glen Canyon Dam.

- 5) Reclamation would, in consultation with the FWS and AGFD, 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 warmwater nonnative species. Depending on the outcome of NPS planning and compliance, Reclamation would implement the plan in coordination with the FWS, AGFD, NPS and GCMRC. Additional coordination would be conducted to determine and access any habitats that may support warmwater nonnatives.

Reclamation produced a report of possible engineered options for modifying the slough in 2018. Using this report, NPS developed a set of tiered actions for addressing green sunfish and other priority nonnative fish species infestations in the slough that were included in the 2019 Expanded Non-Native Aquatic Species EA. This included pump-down and removal of green sunfish, possible chemical treatments, and limited dredging and placement of a water control weir at the outlet thereby facilitating dewatering/refilling and removal of any unwanted fish species including green sunfish. In September 2020 NPS sent approximately 60 fish to an AGFD laboratory to be examined for parasites and disease. In October 2020, NPS removed 3,250 green sunfish from the Upper Slough by pumping water out of the slough and then using a backpack shocker. The fish were quarantined for 2 weeks to ensure that no New Zealand mudsnails were removed and 350 were relocated into Lake Powell near the Wahweap Marina.

- 6) Reclamation would support the GCMRC and NPS in consultation with the FWS and AGFD on the completion of planning and compliance of a plan for implementing rapid response control efforts for newly establishing or existing deleterious invasive nonnative 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 warmwater fish invasions may become a more frequent need in the future with lower reservoir elevations and warmer dam releases.

The NPS Non-Native Aquatic Species Environmental Assessment was completed in 2019 and includes options for rapid response to warmwater fish invasions.

- 7) 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.

Provisional analysis of TMFs by GCMRC researchers indicates that the implementation of trout management flows is limited by researchers' inability to forecast recruitment prior to or during the time period specified in LTEMP (Yard and Korman 2020 ARM presentation). Trout management flows, if effective, may limit immigration of young rainbow trout from Lees Ferry to Marble Canyon. However, conditions in Marble Canyon and below the LCR such as food base, turbidity, and temperature may be more important in determining persistence (Korman and Yard 2020 ARM presentation).

GCMRC is compiling a literature review of TMFs which will help inform decisions related to TMFs. Reclamation is also working on summarizing the current state of knowledge to help inform questions related to TMF design & effectiveness.

SOUTHWESTERN WILLOW FLYCATCHER

- 8) Reclamation would partially assist in funding NPS to conduct Southwestern Willow flycatcher (SWFL) surveys once every other year for the life of the LTEMP.

No surveys were conducted for southwestern willow flycatchers in 2020 per the revised 2018-2020 workplan schedule. The next surveys are planned for 2021.

YUMA RIDGWAY’S RAIL

- 9) Reclamation would partially assist in funding NPS to conduct Yuma Ridgway’s rail surveys once every three years for the life of the LTEMP.

No Yuma Ridgway’s rail surveys were conducted in 2020 per the revised 2018-2020 workplan schedule. The next surveys are planned for 2022.

The table below shows, for each conservation measure, the project that addresses it and the agency responsible for implementing the work.

Table 7. Summary of Conservation Measures as identified in the 2016 Biological Opinion

RESOURCE PROTECTED	CONSERVATION MEASURE	ACTIVITY	AGENCY CONDUCTING WORK
Humpback Chub	Translocation to mainstem tributaries (Shinumo, Havasu, Upper Havasu)	NPS - Humpback Chub Tributary Translocations and Associated Monitoring and Nonnative Fish Control GCMRC - Project G	NPS/GCMRC
	Translocation above Chute falls	GCMRC - Project G	GCMRC/FWS
	Explore other tributaries for translocation potential	GCMRC - Project G; NPS - Humpback Chub Tributary Translocations and Associated Monitoring and Nonnative Fish Control; FWS - coordination with Havasupai Tribe on translocations	GCMRC/NPS/FWS
	Nonnative removal in tributaries prior to translocations	NPS -Humpback Chub Tributary Translocations and Associated Monitoring and Nonnative Fish Control	NPS/GCMRC
	Mainstem aggregations - Expand aggregations outside LCR	GCMRC Project G	GCMRC/FWS
	Mainstem augmentation	GCMRC Project G	GCMRC/FWS
	LCR Monitoring -spring and fall population estimates	GCMRC Project G	GCMRC/FWS
	LCR Monitoring - aggregation monitoring	GCMRC Project G	GCMRC/FWS
	LCR Monitoring - Multistate model	GCMRC Project G	GCMRC
	Mainstem monitoring - Aggregations	GCMRC Project G	GCMRC/NPS/FWS

	Mainstem monitoring - New populations & outside aggregations	GCMRC Project G NPS/Bio-West/FWS	GCMRC/NPS/BioWest/ FWS
	Mainstem monitoring - Parasite monitoring	GCMRC Project I	GCMRC
	Fund FWS Humpback Chub Refuge (SNARRC)	Reclamation	FWS / Reclamation
Razorback Sucker	Habitat use	GCMRC-Project F NPS/BioWest-Razorback Sucker Monitoring & Adaptive Management, Larval & Small-bodied Fish Sampling	GCMRC/NPS/BioWest
	Determine effects of dam operations-TMFs	GCMRC- Project H; NPS-Razorback Sucker Monitoring & Adaptive Management, Larval & Small-bodied Fish Sampling	NPS/GCMRC
	Determine extent of hybridization	Reclamation funded master's degree project	Reclamation
Benefit Native Aquatic Species	Remove brown trout from Bright Angel, inflow & and other areas	GCMRC- Project F NPS-Humpback Chub Tributary Translocations and Associated Monitoring and Nonnative Fish Control	GCMRC/NPS
	Evaluate use of piscicide or other tools to renovate Bright Angel and Shinumo		NPS
	Evaluate TMFs for brown trout	GCMRC-Project H	GCMRC
	Rapid Response	GCMRC- Project I NPS-Invasive Species Monitoring & Management	NPS/GCMRC
	Evaluate temperature control methods	Reclamation Project C.9	Reclamation
	Evaluate means to prevent fish passage through the dam	Reclamation Project C.8	Reclamation
	Backwater slough	NPS- Invasive Species Monitoring and Management	NPS/Reclamation
Southwestern Willow Flycatcher	Monitor every 2 years	NPS - Surveys for Southwestern Willow Flycatchers & Yuma Ridgway's Rail	NPS
Yuma Ridgway's Rail	Monitor every 3 years	NPS - Surveys for Southwestern Willow Flycatchers & Yuma Ridgway's Rail	NPS

SUPPORTING DOCUMENTATION

Work on the 2016 LTEMP BO conservation measures is ongoing. Reclamation has received several final reports detailing activities supporting conservation measures in the 2016 BO. These reports are attached with the transmittal of this document and are identified below.

Attached reports

2019-2020 Bright Angel Creek Brown Trout Control Season Report (*NPS*)
2020 Annual Report of Translocation Activities (*NPS*)
2020 Fish Exclusion and Temperature Control Prize Competition Activities Announcement (*Reclamation*)
2020 Razorback Sucker Research & Monitoring Annual Report (*BioWest*)
2020 Temperature Control Options for Reservoir Release Flows Report (*Reclamation*)
GCMRC FY20 Annual Report (*GCMRC*)
Healy et al. 2020a Native Fish Response to Trout Suppression (*NPS*)
Healy et. al 2020b Humpback chub Translocations to Havasu (*NPS*)
Korman and Yard 2020 ARM What Determines Abundance Rainbow Trout Little Colorado River Confluence (provisional data; *GCMRC*)
Mark-Recapture & Fish Monitoring Activities in the LCR in Grand Canyon 2000-2019 (*FWS*)
Mark-Recapture & Fish Monitoring Activities in the LCR in Grand Canyon 2000-2020 (*FWS*)
Monitoring Humpback Chub Aggregations in the Colorado River, Grand Canyon Fall 2019 (*FWS*)
Yackulic et al. 2020 Bayesian Population Models (*GCMRC*)
Yard and Korman ARM 2020 Trout Recruitment Growth Population Dynamics (provisional data; *GCMRC*)