United States Department of the Interior

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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 Digitally signed by JEFFREY HUMPHREY Date: 2021.06.08 17:51:34 -07'00'

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) 2019

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 2019, 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 LTEMP BO and acknowledge the program made sufficient progress in FY 2019. 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.

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

Fiscal Year 2019

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 2019. 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. 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) 2017 – 2019

The measures described in the Incidental Take Statement of the 2016 LTEMP BO are non-discretionary and must be undertaken by Reclamation when triggered. In order 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 ≥200 mm) 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 three-year average population and recruitment estimates for 2017-2019 are above levels that would require Tier 1 action (see GCMRC FY19 Annual Project Report).

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. Incidental Take Parameters - Tier 1 Action Initiation Triggers, Humpback chub

TIER 1 Early Intervention	# of HBC that triggers an action	OBSERVED # of HBC			
		2017	2018	2019	3-year average
1A. Combined adult HBC mainstem Little Colorado River (LCR) aggregation and juvenile HBC in LCR	≤9000	>9,000	>9,000	>9,000	**>9,000**
OR					
1B. Recruitment of sub-adult HBC does not equal or exceed estimated adult mortality					
Sub-adult in spring estimates	≤1,250 for 3 years	3,146	1,791	2,592	**2,510**
OR					
Sub-adult in mainstem in JCM* Reach	≤810 for 3 years	1,521	945	482	**982**

* Juvenile Chub Monitoring-East (JCM-East) is at RM 62.8-65.9 and JCM-West is near Fall Canyon (RM 210.5 - 214.0)

Table 2. Incidental Take Parameters - Tier 2 Action Termination Triggers, Humpback chub

TIER 2 Mechanical Removal	Action Termination Trigger	OBSERVED			
		2017	2018	2019	3-year average
Nonnative Aquatic Predator index	< 60 rainbow trout / km	--	--	--	--
Immigration rate	to be determined	--	--	--	--
OR					
HBC population estimates	Exceeds 7,500	--	--	--	--
Survival rates of sub-adult chub	Exceeds adult mortality for at least 2 years	--	--	--	--

Conservation Measure Progress, FY 2019

HUMPBACK CHUB

Ongoing Actions:

1) Reclamation would continue to support the NPS, FWS, 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.

      One effort to translocate humpback chub to the Little Colorado River upstream of Chute Falls was conducted in 2019. On October 25, 2019, 307 juvenile humpback chub were released upstream of Chute Falls. FWS and volunteers conducted an annual monitoring trip upstream of RM 13.6 in the LCR. During a trip in May 2019, FWS estimated there were 349 humpback chub ≥ 100 mm total length (TL; Standard Error [SE] = 44) in the Chute Falls reach. Of these, it was estimated that 263 (SE = 33) were adults ≥200 mm TL. In the Atomizer reach, it was estimated that there were 587 humpback chub ≥100 mm TL (SE = 26). Of these, it was estimated that 416 (SE = 20) were adults ≥200 mm TL. Results have also indicated unusually rapid growth of translocated fish, and high apparent survival (see 2019 Annual Report for Project G.7 of the GCDAMP FY2018-20 Triennial Work Plan).

   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 two monitoring trips to Havasu Creek in 2019. In May, 395 humpback chub were captured. Of these, 195 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.* In October, 99 humpback chub captures were recorded, including 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 humpback chub were translocated into Havasu Creek in 2019, due to the unavailability of larval fish during collections in 2018. NPS also conducted two monitoring trips in Shinumo Creek and the adjacent mainstem in 2019. The work in the creek focused on monitoring nonnative rainbow trout, while the mainstem work focused on humpback chub, including those formerly translocated to Shinumo Creek.

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 2019, FWS and volunteers conducted four monitoring trips to monitor humpback chub in the LCR. These trips occurred in April, May, September, and October. The goal of these trips was to monitor the population status and trend of humpback chub in the LCR during spring and fall. During spring 2019, it was estimated that there were 11,210 (SE = 1,300) humpback chub ≥150 mm total length (TL), of which 8,987 (SE = 1,048) were ≥200 mm TL in the LCR. These numbers represent the highest spring abundance of humpback chub in the LCR recorded to date (see 2019 Annual Report for Project G.2 of the GCDAMP FY2018-20 Triennial Work Plan).

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 the Arizona Game and Fish Department (AGFD). Depending on the removal methods identified, additional planning and compliance may be necessary.

In 2019, Grand Canyon National Park operated a weir at the confluence of Bright Angel Creek from October through February. Using this method, 4 brown trout and 5 rainbow trout were removed. Electrofishing was also conducted in Bright Angel Creek and other tributaries from October through December yielding

removal of 1,848 brown trout and 1,823 rainbow trout (see 2018-2019 Bright Angel Creek Brown Trout Control Season Report).

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 2019, a total of 662 larval humpback chub were collected from the LCR and transferred to FWS at the SNARRC. Of these, 629 survived and 400 are now available for translocation with the remaining 229 added to the refuge population held at SNARRC.

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 2019, the new version of the multi-state population model was used to estimate adult humpback chub parameters. This is a Bayesian model that includes random effects. Preliminary comparison of the Bayesian and maximum likelihood models indicate that while survival and movement have varied over time, abundance estimates from the two methods are similar. Humpback chub abundance in this aggregation appears to be stable and is above the Tier 1 threshold of 9,000 individuals (see 2019 Annual Report for Project G of the GCDAMP FY2018-20 Triennial Work Plan). Progress continued in 2019 on development of a mark-recapture model of humpback chub spawning dynamics in the LCR aggregation, construction of a model assessing the effectiveness of humpback chub translocations upstream of Chute Falls, and a recent publication that describes a new approach to model building that includes a modeling

example from the LCR humpback chub aggregation (see Yackulic et al. 2020).

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 2019, there were three juvenile humpback chub monitoring trips (occurring in May, July, and October) in the JCM-East site. In total, all JCM-East trips captured 1038 humpback chub >79mm TL and 275 humpback chub between (40-79 mm TL). Specific numbers of humpback chub that were captured at each location are listed in the table below. (All humpback chub > 79 mm TL were marked with passive integrated transponder (PIT) tags, and all humpback chub between 40-79 mm TL were marked using visual implant elastomer (VIE).

Table 3. The number of juvenile humpback chub of each size identified during monitoring trips conducted from May to October of 2019.

Location	May		July		October		TOTAL	
	>79 mm	40-79 mm	>79 mm	40-79 mm	>79 mm	40-79 mm	>79 mm	40-79 mm
JCM-East	143	35	246	51	649	189	1,038	275
JCM-West	302	19	880	31	379	51	1,561	101

iii. 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).

This is being addressed in Project G of the GCDAMP FY2018-20 Triennial Work Plan. Preliminary results and an update on progress will be available in the GCMRC FY2020 Annual Report, Project G.

iv. 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.

This is being addressed in Project G of the GCDAMP FY2018-20 Triennial Work Plan. Preliminary results and an update on progress will be available in the GCMRC FY2020 Annual Report, Project G.

6) Reclamation would, through the GCDAMP, conduct disease and parasite monitoring in humpback chub and other fishes in the mainstem Colorado. The U.S. Geological Survey (USGS) and GCMRC are 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 2019, GCMRC sampled humpback chub at Boulder's Camp along the Little Colorado River and analyzed them for Asian tapeworm. Twelve tapeworms were found in 43 humpback chub of various sizes.

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.

This conservation measure is being addressed in Project G of the GCDAMP FY2018-20 Triennial Work Plan. Preliminary results and an update on progress will be available in the GCMRC FY2020 Annual Report, Project G.

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

This conservation measure is being addressed in Project G of the GCDAMP FY2018-2020 Triennial Work Plan. Preliminary results and an update on progress will be available in the GCMRC FY2020 Annual Report, Project G.

NPS continues to monitor the recovery of Shinumo Creek in order to evaluate its potential for future humpback chub translocations.

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.

   Reclamation funded a three-year study for a graduate student at Northern Arizona University to develop field identification tools for flannelmouth/ razorback hybrid suckers, and evaluate hybrid viability. Results indicate that hybrids and razorbacks hatch and survive at similar rates. Hybrids are an intermediate shape between flannelmouth and razorback sucker but look more like razorback sucker. Field identification is difficult until fish reach a size > 250 mm, which makes it difficult to identify hybrids using morphometric measurements only. This work was summarized in a manuscript published in 2019 (Wolters PN, Rogowski DL, Ward DL, and Gibb AC. 2019. Viability of Razorback-Flannelmouth Sucker Hybrids. The Southwestern Naturalist 63(4):280).

   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 sixth consecutive year, larval fish sampling verified razorback sucker spawning and larval production in the Colorado River within Grand Canyon National Park. In 2019, larval razorback suckers (n=8) were captured only during April and May and were distributed from river mile (RM) 127.3 to RM 279.0. The May capture of one razorback sucker (n=1) at RM 127.3 is the farthest upstream razorback sucker larva has been captured within the expanded study area (2016‑2019; RM 88.6‑279.0). This finding extends the distribution of age-0 razorback sucker 17.5 RM farther upstream than the previously identified most-upstream capture of razorback sucker in 2018 (n=1, RM 144.8). All except one of the 2019 captured larval razorback suckers were collected in May (n=7).

The number of larval razorback sucker taken per sampling year has continued to decline since the 2014 start of this study (2014=462, 2015=81, 2016=46, 2017=27, 2018=10, 2019=8). Larval razorback sucker collected were represented by two ontogenetic phases (protolarvae and flexion and postflexion mesolarval subphases). The developmental stages of these few fish combined with their location of capture strongly suggest multiple spawning locations. The range of total length-based (TL) back-calculated hatching dates encompassed only the 5 weeks from March 30th to May 5, 2019, a shorter spawning season than previous years. This ongoing study is also collecting baseline, pre-flow experiment data to inform an analysis of impacts of flow experiments on razorback and their habitat (2019 Razorback Sucker Research & Monitoring Annual Report).

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

No TMFs have occurred under the LTEMP, nor have they been scheduled to be tested. On November 5-8, 2018, the Department of the Interior conducted a High Flow Experiment (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 fall HFE. The mean annual native fish catch rates did not reveal any difference in small-bodied native fish catch rates in 2019 compared to previous years indicating the fall HFE did not significantly impact native fish populations (see 2019 Razorback Sucker Research & Monitoring Annual Report). Annual small-bodied native fish catch rates do not appear to be significantly correlated with annual release volumes from Glen Canyon Dam. 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").

   Prior to tribal consultation, NPS continues to monitor the recovery of Shinumo Creek in order to evaluate its potential for future humpback chub translocations and/or chemical piscicide treatment.

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 5, 2019 through February 20, 2020, a modified resistance board weir with a downstream-orientated fish trap was installed in Bright Angel Creek near its confluence with the Colorado River. For a fifth consecutive season, trout captures in the weir itself remained low. The 2019-2020 Bright Angel Creek electrofishing season spanned October 22, 2019– January 28, 2020 (2018-2019 Bright Angel Creek Brown Trout Control Season Report). Stream-wide native fish abundance continued to exceed baseline levels developed in 2012-2013, while total salmonid abundance was ~95% lower compared to 2012 – 2013 abundance.

   Humpback chub that were translocated to Bright Angel Creek in 2019 were detected during monitoring, both via electrofishing and on the installed passive PIT-tag detection antenna (see 2019 Annual Report of Translocation Activities).

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 (Denver) has undertaken a review of temperature control options for reservoir release flows in 2019. A final report will be released in January 2020 with a detailed review of existing temperature control options for controlling reservoir release temperatures. The report will also outline new partnership opportunities, identify external subject matter experts, and recommend future actions. Reclamation is interested in identifying technologies that could be utilized broadly throughout the West, as well as specifically at 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's Research and Development Office ran a prize competition called "Improving Fish Exclusion from Water Diversions and Intakes" in 2019. A brief summary of existing technologies was completed by subject matter experts during the prize competition effort. Reviewers included subject matter experts from Reclamation, U.S. Army Corps of Engineers, NOAA Fisheries, U.S. Geological Survey, Department of Energy's Water Power Technologies Office, Pacific Northwest National Laboratory, U.S. Fish and Wildlife Service, and State of Washington Department of Fish and Wildlife. Information can be found at: https://www.usbr.gov/research/challenges/fishexclusion.html.

Six winners were awarded a total of $75,000. Reclamation did not take a license to the solutions and intellectual property is protected. Further exploration of these technologies is being pursued and progress on this topic will be reported in 2020.

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 for developing options for modifying the slough in 2018. NPS included various options for addressing the slough in the 2019 Non-Native Fish EA including dredging, dewatering, chemical control to be applied dependent on annual conditions in the slough.

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.

A plan that is closely tied to the 2019 Non-Native Aquatic Species Environmental Assessment will be prepared in coordination with NPS, GCMRC, Arizona Game & Fish, and Reclamation. GCMRC is conducting work in Project I of the GCDAMP FY2018-20 Triennial Work Plan to inform the plan.

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.

TMFs are not yet scheduled to occur but Projects H, I and J of the GCDAMP FY2018-20 Triennial Work Plan include research designed to help inform decisions related to TMFs.

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.

In 2019 the NPS conducted 3 full river surveys (May, June, and July) for the Southwestern Willow flycatcher (SWFL) per FWS protocol. SWFL surveys were conducted within Grand Canyon National Park between May 15-June 1, June 8-19, and July 1-July 11. No SWFLs were detected (see 2019 Avifauna Surveys).

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.

Two wetland bird surveys for Yuma Ridgway's rail were conducted on April 3rd and April 17, 2019 at river mile 275. None were detected; Virginia rail, Sora, and least bitterns were identified during the first survey and Virginia rails were identified on the second survey. While the marsh remains intact, this area burned in the winter of 2018, which may have impacted the suitable habitat (see 2019 Avifauna Surveys).

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

Table 4. 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
Riparian	Experimental Vegetation Treatment & Mitigation	**GCMRC-** Project C **NPS-** Non-Flow Vegetation Treatment Actions	NPS/GCMRC

SUPPORTING DOCUMENTATION

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

Attached reports

2018-2019 Bright Angel Creek Brown Trout Control Season Report
2019 Annual Report of Translocation Activities
2019 Avifauna Surveys
2019 FONSI Non-Native Aquatic Species Monitoring Plan
2019 HBC Translocation Activities
2019 June 16-18 LCR HBC Collection Trip
2019 June Shinumo Translocation Trip Report
2019 May Havasu Creek Translocation Trip Report
2019 October Havasu Creek Translocation Trip Report

2019 Razorback Sucker Research & Monitoring Annual Report
2019 September Shinumo Translocation Trip Report
2019 Southwestern Willow Flycatcher Data
2019 Yuma Ridgway's Rail Activities
2019 Yuma Ridgway's Rail RM275 Datasheets
AGFD Lees Ferry Fall 2019 Trip Report
AGFD Lees Ferry Summer 2019 Trip Report
GCMRC FY19 Annual Project Report
Pilar et al. 2019 Viability of Razorback-Flannel Mouth Sucker Hybrids
VanHaverbeke et al. Mark-Recapture and Fish Monitoring Activities in the Little Colorado River in Grand Canyon from 2000 to 2019
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