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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

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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) 2018

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 2018, 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 2018. 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 2018

LTEMP BO 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 2018. 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.

Incidental Take Summary for Fiscal Years (FY) 2016 – 2018

The measures described in the Incidental Take Statement¹ of the 2016 LTEMP BO are non-discretionary, and must be undertaken by Reclamation. 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 2016-2018 are above levels that would require Tier 1 action (see GCMRC FY18 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.

¹ Section 9 of the Endangered Species Act (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. "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.

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			
		2016	2017	2018	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	749	3,146	1,791	1,895
OR					
Sub-adult in mainstem in JCM* Reach	≤810 for 3 years	> 810	1,521	945	1,092

* 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	Termination Trigger	OBSERVED			
		2016	2017	2018	3-year average
Nonnative Aquatic Predator index	< 60 Rainbow trout/ km*	--	--	--	--
Immigration rate	Low (exact # 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 Measures Progress, FY2018

HUMPBACK CHUB

Ongoing Actions:

- 1) Reclamation would continue to support the National Park Service (NPS), U.S. Fish & Wildlife Service (FWS), U.S. Geological Survey 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], FWS Humpback Chub Genetics Management Plan and Translocation Framework, and GCMRC Triennial Work Plan). Specifically, the following would occur:

In 2018, Grand Canyon National Park (GRCA) continued implementation of the Comprehensive Fisheries Management Plan for native fish within GRCA and sport fish in the Lees Ferry area of the Glen Canyon National Recreation Area. These efforts included an evaluation of the status and habitat use of endangered razorback sucker, translocations and/or monitoring of endangered humpback chub to Havasu and Bright Angel creeks, and the removal of non-native fishes threatening endangered and native fish in Bright Angel Creek.

- 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.

On October 26, 2018, FWS translocated 49 humpback chub upstream of Chute Falls (at river mile 16.2). It is thought that no spring runoff in the Little Colorado River (LCR) during spring 2018 resulted in very poor production of age-0 humpback chub. That, combined with LCR flooding during the October 2018 collection effort, resulted in an unusually low number of humpback chub being captured and subsequently translocated upstream of Chute Falls. FWS also continued to monitor humpback chub abundance upstream of Chute Falls. During a trip in May 2018, it was estimated there were 254 humpback chub ≥ 100 mm total length (TL; Standard Error [SE] = 17) in the Chute Falls reach. Of these, it was estimated that 157 (SE = 10) were adults ≥ 200 mm TL. In the Atomizer

reach, it was estimated that there were 173 humpback chub ≥ 100 mm TL (SE = 4). Of these, it was estimated that 141 (SE = 3) were adults ≥ 200 mm TL (see GCMRC FY18 Annual Project Report Project G.7 on page 85).

- 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 in Havasu Creek in 2018. In May, 395 humpback chub captures (195 of these were non-translocated fish), were made during two passes of netting. Strong cohorts of age-1 juvenile humpback chub were common in the samples and multiple age-classes of translocated and Havasu Creek-spawned humpback chub were present. In October, a flash flood occurred while crews were on site, necessitating the release of all nets and a quick retreat by crew members. No humpback chub were translocated in 2018, due to the unavailability of larval fish during collection attempts in 2017.

NPS also conducted one monitoring trip in Shinumo Creek and the adjacent mainstem in 2018. The work in the creek focused on monitoring non-native rainbow trout, while the mainstem work focused on humpback chub, including those formerly translocated to Shinumo Creek. Prior to a 2014 fire and severe monsoonal flooding, Shinumo Creek was a translocation site for humpback chub. These monitoring trips also serve to document the recovery of the creek for potential future translocations.

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

In 2018, FWS and volunteers conducted three monitoring trips to monitor humpback chub in the LCR. These trips occurred in April, May, and September. A fourth trip, scheduled for October, was cancelled because of inclement weather and severe flooding. The goal of these trips was to monitor the population, status, and trends of humpback chub in the LCR during spring and fall. During spring 2018, it was estimated that there were 9,768 (SE = 670) humpback chub ≥ 150 mm TL, of which 7,948 (SE = 617) were ≥ 200 mm TL. These numbers represent the highest spring abundance of humpback chub in the LCR recorded to date and indicate

that, since 2015 and 2016, abundances have increased significantly (see 2018 Annual Report for Project G of the GCDAMP FY2018-20 Triennial Work Plan; Mark-Recapture & Fish Monitoring Activities in the LCR from 2000-2018).

- 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.

Following a multi-year effort to reduce the abundance of nonnative brown trout and rainbow trout in Bright Angel Creek, translocation of 116 humpback chub to Bright Angel Creek occurred on May 14, 2018. The recovery of habitat in Shinumo Creek following a fire and flood was also monitored, but no fish were translocated there in 2018 and thus no non-native fish removal occurred.

- 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 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.

Because of the low number of larval humpback chub caught in 2018, no fish were provided to SNARRC. On May 14, 2018, 116 of the fish held from previous collections at SNARRC were transferred to NPS and translocated to Bright Angel Creek.

- 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 2018, a new version of the multi-state population model was used to estimate adult humpback chub parameters. The Bayesian model includes random effects. Preliminary comparison of the Bayesian and maximum likelihood models indicates 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 GCMRC FY18 Annual Report Project G).

- 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 2018, there were three juvenile chub monitoring (JCM) trips (occurring in May, July, and October) that occurred in the Colorado River at the JCM-east site (RM 62.8-65.9) and the Colorado River near Fall Canyon (JCM-west; RM 210.5 - 214.0). In addition, mainstem Colorado River humpback chub aggregations were monitored for relative abundance and distribution during an August 21 - September 7, 2018 river trip. Inferences on the status and trends of humpback chub within aggregations for this work is primarily based on hoop net catches, which is used to construct a long term catch per unit effort (CPUE) index. 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). See Table below for number of humpback chub caught in each reach during the monitoring trips.

Table 3. The number of juvenile humpback chub of each size identified during monitoring trips conducted from May to October of 2018.

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	155	202	253	179	301	71	709	452
JCM-West	159	191	453	411	118	45	730	647

- 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 FY 2019 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 FY 2019 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. GCMRC is currently conducting parasite monitoring in the LCR. 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 2018, GCMRC sampled humpback chub at Boulders Camp along the LCR and at Bridge City below Diamond Creek and analyzed them for Asian tapeworm. Six tapeworms were detected in 36 humpback chub of various sizes in the LCR and no tapeworms were detected in 43 humpback chub of various sizes sampled at Bridge City.

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 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 FY 2018 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 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 FY18 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 Northern Arizona University graduate student to develop field identification tools for flannelmouth/razorback hybrid suckers and to 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 that was submitted for publication to the Southwestern Naturalist.

- 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.

Habitat use of adult razorback sucker is primarily in the inflow area of Lake Mead as determined by sonic and radio tracking. One adult fish was detected as far upstream as Pipe Springs near Bright Angel Creek in 2017 and numerous fish have been detected in the river especially downstream

of Lava Falls Rapid. In 2018, numerous larval razorbacks are captured in all habitats downstream of Havasu Creek, including backwaters, slackwaters and runs in the main channel. No small-bodied razorback sucker were captured in the Grand Canyon study area in 2018 (or in any year of the study); this is consistent with studies in other razorback sucker studies throughout the Basin.

Grand Canyon small-bodied fish community sampling in 2018 resulted in the capture of four native and eight non-native fish species, as well as documentation of young-of-the-year (age-0) catostomid and cyprinid fishes. Seining results indicated that native species (particularly native suckers) dominate the Grand Canyon fish community, especially below Havasu Creek. No razorback suckers were captured during small-bodied fish seining efforts within the Grand Canyon study area. However, larval fish community sampling resulted in the capture of early life stage razorback suckers in the Grand Canyon. This, along with capturing other native fish species in the Grand Canyon during small-bodied fish community sampling and tracking sonic-tagged fish movement within Lake Mead and the Grand Canyon, suggests that we can use sampling to identify the larvae and juveniles of species that have life histories and ecological traits similar to Razorback Sucker. The ongoing study is also collecting baseline, pre-flow experiment data to inform an analysis of impacts of flow experiments on razorback and their habitat (see 2018 Razorback Sucker Research & Monitoring Annual Report for more details).

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

No TMFs or HFEs have occurred under LTEMP and the 2016 BO, nor have they been scheduled to be tested. Baseline data collected in the razorback project described above will be used to evaluate the effects of flow experiments when they occur. Additional data will be collected during and after a flow experiments to assess the effects on razorback suckers.

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”).

This project will continue following the completion of the Expanded Non-native Species Management Plan in Glen Canyon NRA and Grand Canyon NP below Glen Canyon Dam EA. Prior to compliance and 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.

Trout reduction in Bright Angel Creek was modified in the 2018-2019 season, per recommendations from a peer-reviewed evaluation. From October 10, 2018 through February 19, 2019, 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 fourth consecutive season, trout captures in the weir itself remained low. A total of four brown trout and five rainbow trout were captured in the weir during the season. The 2018-2019 Bright Angel Creek electrofishing season spanned October 23, 2018– December 20, 2018. A total of 1,848 brown trout and 1,823 rainbow trout were removed during the electrofishing season. Native fish species continued to increase in number and in distribution through the creek, coincident with lower trout numbers. All trout removed from Bright Angel Creek are prepared and distributed for beneficial use, according to stipulations in a memorandum of agreement with the Arizona State Historic Preservation Office, in compliance with Section 106 of the National Historic Preservation Act. A detailed analysis is included in the Annual Report prepared by NPS for Reclamation.

After five years of annual trout removal via electrofishing throughout Bright Angel Creek and operation of a weir near the confluence, a peer review panel found that both prerequisites—trout suppression and positive native fish response—were judged adequately successful to proceed with the first humpback chub translocation to the creek. Experimental translocations of humpback chub were initiated in May of 2018.

Bright Angel Creek was sampled for translocated humpback chub using hoop nets from September 16-19, 2018. The creek was flooding and highly turbid during sampling, and captures were subsequently low.

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.

The technical services center developed a report evaluating temperature reduction options for the Glen Canyon Slough (see attached report).

- 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 plans to pursue assistance on this topic from Technical Services.

- 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 has engaged Technical Services and the Provo field office for potential plans and has had surveys conducted. This project will be implemented following the completion of the Expanded Non-native Species Management Plan in Glen Canyon NRA and GRCA below Glen Canyon Dam EA.

- 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.

This effort will be closely tied to the Expanded Non-native Species Management Plan in Glen Canyon NRA and Grand Canyon NP below Glen Canyon Dam EA. A plan will be prepared in coordination with NPS, GCMRC, AZGF, and Reclamation on completion of the EA and is being addressed in Project I of the GCDAMP FY2018-20 Triennial Work Plan.

- 7) Reclamation, in cooperation with the GCDAMP, would review and modify as appropriate the experimental use of TMFs to inhibit brown trout spawning and recruitment in Glen Canyon, or other mainstem locations.

TMFs are not yet scheduled to occur, but are addressed in Project H, I and J of the GCDAMP FY2018-20 Triennial Work Plan. Reclamation intends to first test TMFs as outlined in the LTEMP to determine the effectiveness on brown trout. The experimental design of TMFs will be coordinated in cooperation with the GCMRC and GCDAMP to maximize effectiveness to inhibit brown trout spawning and recruitment in Glen Canyon. After reviewing the effectiveness of the first tests, Reclamation will work with the GCDAMP to modify TMFs as appropriate.

SOUTHWESTERN WILLOW FLYCATCHER and YUMA RIDGWAY'S RAIL

- 8) 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 NPS Yuma Ridgway's rail surveys were conducted in 2018 per the revised 2018-2020 workplan schedule.

- 9) Reclamation would partially assist in funding NPS to conduct southwestern willow-flycatcher surveys once every two years for the life of the LTEMP.

No surveys were conducted for southwestern willow flycatchers in 2018 per the revised 2018-2020 workplan schedule.

Table 4 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

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 below.

Attached reports

2017-2018 Bright Angel Creek Brown Trout Season Report
2018 Bright Angel Creek Trout Control 5-year Summary
2018 Fall & 2019 Spring Bright Angel HBC Translocation Trip Report
2018 June HBC Shinumo Creek River Mission Report
2018 June Shinumo Creek Monitoring Trip Report
2018 May Bright Angel Creek HBC Translocation Trip Report
2018 May Havasu Creek HBC Translocation Trip Report
2018 Peer Review of Bright Angel Creek Comprehensive Non-Native Trout Control
2018 Razorback Sucker Research & Monitoring Annual Report
2018-2019 Bright Angel Creek Brown Trout Control Season Report
Brown Trout below Glen Canyon Dam White Paper Risk Analysis
GCMRC FY18 Annual Project Report
Mark-Recapture & Fish Monitoring Activities in the LCR from 2000-2018
Monitoring Humpback Chub Aggregations in GRCA in 2018
Review of Effective Suppression of Nonnative Fishes in Bright Angel Creek 2012-2017
Temperature Reduction Options for Glen Canyon Slough; RM -12