RECLAMATION
Managing Water in the West

Report to Congress
Operations of Glen Canyon Dam
Pursuant to the Grand Canyon Protection Act of 1992

Water Years 2017-2018

U.S. Department of the Interior
Bureau of Reclamation

August 2018

EXECUTIVE SUMMARY

This report by the Department of the Interior (Interior) is submitted pursuant to the Grand Canyon Protection Act (GCPA) of 1992. Pub. L. 102-575, which provides:

> Each year after the date of the adoption of criteria and operating plans pursuant to paragraph (1), the Secretary shall transmit to the Congress and to the Governors of the Colorado River Basin States a report, separate from and in addition to the report specified in section 602(b) of the Colorado River Basin Project Act of 1968 on the preceding year and the projected year operations undertaken pursuant to this Act.

Id., § 1804(c)(2). This report provides an update from the last report, which was submitted on December 12, 2017, by Interior for years 2016 (observed) and 2017 (projected). The current report covers dam operations and other activities undertaken pursuant to the GCPA for 2017 (observed) and 2018 (projected). In this report, the timeframe for water and fiscal years is identical, October 1 through September 30.

INTRODUCTION

Glen Canyon Dam was authorized for construction by the Colorado River Storage Project Act of 1956. See 43 U.S.C. § 620. The dam was completed in 1963 and is operated by the Bureau of Reclamation (Reclamation). In 1992, Congress enacted the GCPA, which requires the Secretary of the Department of the Interior (Secretary) to operate Glen Canyon Dam…

> [I]n accordance with the additional criteria and operating plans specified in section 1804 and exercise other authorities under existing law in such a manner as to protect, mitigate adverse impacts to, and improve the values for which Grand Canyon National Park and Glen Canyon National Recreation Area were established, including, but not limited to natural and cultural resources and visitor use.

See Pub. L. 102-575, § 1802(a). Congress also directed that such operations be undertaken

> [I]n a manner fully consistent with and subject to the Colorado River Compact, the Upper Colorado River Basin Compact, the Water Treaty of 1944 with Mexico, the decree of the Supreme Court in Arizona v. California, and the provisions of the Colorado River Storage Project Act of 1956 and the Colorado River Basin Project Act of 1968 that govern allocation, appropriation, development, and exportation of the waters of the Colorado River basin.

Id., § 1802(b). In 1997, the Secretary established the Glen Canyon Dam Adaptive Management Program (AMP) to carry out the requirements of the GCPA. As part of the AMP, the Secretary also established the Adaptive Management Work Group (AMWG), a 25-member federal advisory committee that operates pursuant to the provisions of the Federal Advisory Committee Act, 5 U.S.C. § App. 2. The Secretary's Designee is the Assistant Secretary for Water and Science who serves as the Chair of the AMWG.

STATUS REPORT

Five agencies within Interior have responsibilities under the GCPA and undertake operations pursuant to the GCPA; the: (1) Bureau of Indian Affairs (BIA); (2) Reclamation; (3) National Park Service (NPS); (4) United States Fish and Wildlife Service (FWS); and (5) United States Geological Survey (USGS). Collectively these five agencies fund five American Indian Tribes (Hopi, Hualapai, Pueblo of Zuni, Kaibab Paiute, and the Navajo Nation) to participate in the AMP and two Tribal Liaison positions within Interior that assist in coordination between Interior and the tribes. The Western Area Power Administration (WAPA) also has statutory responsibilities pursuant to the Department of Energy Organization Act, Flood Control Act, Reclamation Project Act, Colorado River Storage Project Act, and the GCPA. The role of each responsible Interior agency under the GCPA is briefly addressed below.

BIA

The BIA's mission, among other objectives, includes enhancing quality of life, promoting economic opportunity, and protecting and improving trust assets of Indian Tribes and individual American Indians. This is accomplished within the framework of a government-to-government relationship in which the spirit of Indian self-determination is paramount. As part of the AMWG, the BIA works hand-in-hand with interested tribes and other participating agencies to ensure that this fragile, unique, and traditionally important landscape is preserved and protected.

Reclamation

Reclamation operates Glen Canyon Dam in accordance with and subject to interstate compacts, an international treaty, federal laws, court decisions and decrees, contracts, and regulatory guidelines collectively known as the "Law of the River," additional criteria and operating plans specified in section 1804 of the GCPA, and approved experimental plans. Reclamation also provides support to the Secretary's Designee in administering the AMP, including coordinating logistics for the AMWG and the Technical Work Group (TWG).

NPS

The NPS manages units of the national park system and administers resource-related programs under the authority of various federal statutes, regulations, and executive orders, and in accordance with written policies set forth by the Secretary and the Director of the NPS, including the NPS Management Policies 2006 and the NPS Director's Orders. The NPS manages Grand Canyon National Park and Glen Canyon National Recreation Area under the NPS Organic Act, 16 U.S.C. §§ 1 and 2-4, as amended; other acts of Congress applicable generally to units of the national park system; and the legislation specifically establishing those park units. See 16 U.S.C. §§ 221-228j and 16 U.S.C. §§ 460dd through 460dd-9 (2006). The NPS Organic Act directs the NPS to "promote and regulate the use of . . . national parks . . . in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." The NPS helps the Secretary achieve the goals outlined in the GCPA through its resource management and resource monitoring activities.

FWS

The FWS provides Endangered Species Act (ESA) conservation and associated consultation and recovery leadership with various stakeholders primarily to benefit five listed species: the humpback chub (*Gila cypha*), razorback sucker (*Xyrauchen texanus*), southwestern willow flycatcher (*Empidonax trailii extimus*), yellow-billed cuckoo (*Coccyzus americanus*), and Kanab ambersnail (*Oxyloma haydeni kanabensi*).

USGS

The Grand Canyon Monitoring and Research Center (GCMRC) of the USGS was created to fulfill the mandate in the GCPA for the establishment and implementation of a long-term monitoring and research program for natural, cultural, and recreational resources of Grand Canyon National Park and Glen Canyon National Recreation Area. GCMRC provides independent, policy-neutral scientific information to the AMP on (1) the effects of the operation of Glen Canyon Dam and other related factors on resources of the Colorado River ecosystem using an ecosystem approach, and (2) the flow and non-flow measures to mitigate adverse effects. The GCMRC's activities are focused on (1) monitoring the status and trends in natural, cultural, and recreational resources that are affected by dam operations, and (2) working with land and resource management agencies in an adaptive management framework to carry out and evaluate the effectiveness of alternative dam operations and other resource conservation actions described in this report.

2017 OPERATIONS

BIA

In water year 2017, the BIA participated in consultation meetings with the tribes regarding the Tribal Consultation Plan, conducted pre-meetings with tribal representatives prior to the AMWG meetings, met with the Interior Tribal Liaisons to discuss tribal concerns, and participated in meetings regarding cultural and natural resources issues and concerns. Principal among tribal concerns for 2017 remains the importance of traditional cultural values and Reclamation is working to better consult with tribes. The tribes are especially concerned with the mechanical removal of non-native fish in the Colorado River. The BIA submitted AMWG member and alternate nominating letters for consideration and processing. The BIA continued to provide its portion of funding to tribes for their participation in the AMP. Other activities included continued coordination of efforts for tribal participation in the AMP, coordinating with other agencies on whether or not to conduct a fall high-flow experiment (HFE), reviewing annual tribal monitoring reports, commenting on the Programmatic Agreement, and continuing to work with the Interior Tribal Liaisons to maximize tribal consultation and involvement.

Reclamation

Water Operations

The August 2016 24-Month Study projected the January 1, 2017, elevations of Lake Powell and Lake Mead to determine the water year 2017 operating tier for Lake Powell. Using the most probable inflow scenario, and with an 8.23 million acre-feet (MAF) annual release pattern for Lake Powell, the January 1, 2017, reservoir elevations of Lake Powell and Lake Mead were projected to be 3,605.83 feet and 1,078.93 feet, respectively. Given these projections, the annual release volume from Lake Powell during water year 2017 was consistent with the Upper Elevation Balancing Tier (section 6.B of the 2007 Interim Guidelines) and under section 6.B.1, the annual release would be 8.23 MAF.

The Upper Elevation Balancing Tier provides for the possibility of adjustments to the operation of Lake Powell based on the projected end of water year condition of Lake Powell and Lake Mead from the April 24-Month Study. The April 2017 24-Month Study was run with an 8.23 MAF annual release volume to project the September 30, 2017, elevations of Lake Powell and Lake Mead. Under the most probable inflow scenario, and with an 8.23 MAF annual release volume, the projected end of water year elevation at Lake Powell was 3,646.82 feet and Lake Mead was 1,072.07 feet. Since the projected end of water year elevation at Lake Powell was below the 2017 Equalization elevation of 3,652 feet and above 3,575 feet, and the projected Lake Mead elevation was below 1,075 feet, section 6.B.4 of the 2007 Interim Guidelines governed for the remainder of water year 2017. Under section 6.B.4, the Secretary shall balance the contents of Lake Mead and Lake Powell, but shall release not more than nine MAF and not less than 8.23 MAF from Lake Powell. The annual release volume during water year 2017 was 9.00 MAF.

The fourth experimental release under the High-Flow Experimental (HFE) Protocol was successfully conducted during November 2016 (water year 2017). Reclamation released the maximum available capacity, 38,000 cubic feet per second, during the experiment, which began on November 7 and ended on November 12, 2016. Preliminary findings suggest that the first four HFE releases have been very successful in transporting sediment accumulated near the confluence of the Colorado and Paria rivers to beaches and sandbars where sediment replenishment was needed. Though erosion occurs at most monitored sandbars as a result of normal dam operations in the months following an HFE, the most recent topographic surveys of long-term monitoring sites indicate sandbars increased in size during the first five years of implementation of the HFE Protocol. Reports from the Grand Canyon white water rafting community have been positive on the improvement of beaches in Grand Canyon over the five-year period that the HFE Protocol has been in place. Fisheries researchers have also indicated that these releases have temporarily rebuilt important backwater habitats where sandbars are adequately enhanced throughout Grand Canyon.

The total annual release from Glen Canyon Dam in water year 2017 did not change as a result of the HFE. The monthly release volumes for water year 2017 are displayed in Table 1. The end of water year 2017 elevation for Lake Powell was 3,628 feet.

Table 1. Lake Powell Monthly Release Volumes
Water Year 2017

Month	Monthly Release Volumes (MAF)
October 2016	0.601
November 2016	0.750
December 2016	0.898
January 2017	0.880
February 2017	0.711
March 2017	0.723
April 2017	0.623
May 2017	0.652
June 2017	0.749
July 2017	0.850
August 2017	0.900
September 2017	0.663
Total Releases	9.000

The ten-year total flow of the Colorado River at Lees Ferry[1] for water years 2008 through 2017 was 91.67 maf (USGS stream flows, Lees Ferry plus Paria River gage data). This total is computed as the sum of the flow of the Colorado River at Lees Ferry, Arizona, and the Paria River at Lees Ferry, Arizona, surface water discharge stations which are operated and maintained by the USGS.

Long-Term Experimental and Management Plan (LTEMP) Environmental Impact Statement (EIS)

Interior, through Reclamation and the NPS, jointly published the final LTEMP EIS on October 7, 2016, and a Record of Decision (ROD) was signed on December 15, 2016. The purpose of the LTEMP is to increase scientific understanding of the ecosystem downstream from Glen Canyon Dam and to improve and protect important downstream resources, while maintaining compliance with relevant laws including the GCPA, "Law of the River," and ESA. The EIS had 15 cooperating agencies (including six tribes). A primary function of the LTEMP EIS is to continue the successful experiments completed under the AMP.

Conservation Measures for Humpback Chub and Razorback Sucker

From fiscal years 2009 through 2017, Reclamation has funded the NPS to remove non-native brown and rainbow trout and translocate humpback chub into two tributaries: Shinumo Creek and Havasu Creek. Scientists have determined that the completion of a five-year adaptive management action to remove non-native trout has been adequately successful in Bright Angel Creek, and humpback chub will be translocated in 2018. These actions are implemented to fulfill: (1) conservation measures from two biological opinions (BO) on the operations of Glen Canyon Dam, and (2) recovery goals as defined by the FWS for establishing additional reproducing populations of humpback chub. These efforts are to provide additional refuge

[1] A point in the mainstream of the Colorado River one mile below the mouth of the Paria River.

populations that minimize the effects of predation and competition from non-native fish, contribute to mainstem populations of humpback chub, and may eventually establish new spawning populations.

Although the 2016 LTEMP BO replaced the 2011 BO, many of the conservation measures in the 2011 BO were continued in the 2016 BO, with some adjustments based on emerging science. New actions are mostly in anticipation of potential hydrological conditions that could result in non-native fish establishment. Further planning and compliance may be needed to implement components of the new conservation measures.

Translocations into Shinumo Creek that occurred from 2009 to 2013 were discontinued. In May 2014, a lightning-caused fire burned 6,100 acres in the drainage followed by monsoon flood events in July and August. These events flushed and scoured the aquatic fauna from the creek and greatly altered habitat conditions making it unsuitable for fish. Monitoring of Shinumo Creek has continued to determine the recovery and suitability of the habitat. The habitat has improved and humpback chub translocations may resume in 2018.

Juvenile humpback chub have been translocated to Havasu Creek since 2011. Two monitoring trips per year are conducted to determine abundance, annual survival, and growth estimates for the translocated humpback chub. These data indicate that the objectives of the translocations are being met and in addition, non-tagged or non-translocated humpback chub and chub less than 150 millimeters have also been captured. Their occurrence indicates that there are naturally occurring humpback chub in Havasu Creek that are reproducing. Evidence of reproduction has been consistently demonstrated since 2012. Consequently, a spawning population may be present and translocations will likely occur in the future only to assure the genetic diversity of the population.

Monitoring has shown that abundance of adult chub in the mainstem has increased or remained stable at all aggregations since sampling began in the 1990s. Humpback chub adults are currently abundant (more than 12,000 adults) and expanding in range. Humpback chub translocations to Shinumo Creek and Havasu Creek began in 2009 and have also contributed to the mainstem aggregations located at the tributary mouths. Mainstem aggregation sampling indicates that humpback chub translocated into Shinumo and Havasu tributaries are approximately 70 percent and 35 percent of the total aggregation, respectively. Other areas not associated with known aggregations were sampled the last four years and results indicate that chub are more widely distributed in the mainstem than had been detected previously. This is likely a result of emerging habitat below Diamond Creek, including warmer water temperatures and low predator burden. There has also been an expansion of chub below river mile (RM) 30. This may be related to several springs that enter the mainstem at this location that have warmer water than the mainstem.

The razorback sucker was thought to be extirpated from the Grand Canyon reach of the Colorado River. However, in 2013, two razorbacks were captured downstream of Diamond Creek (RM 225), more than 50 miles upstream from Pearce Ferry near the inflow of the Colorado River to Lake Mead and the termination of Grand Canyon. Consequently, Reclamation continued financial and staff support of a monitoring project for razorback sucker aimed at better

understanding the use and life history needs of the species in Lake Mead and western Grand Canyon.

While researchers have known that razorback sucker occupy and are able to reproduce and recruit in Lake Mead since the 1990s, this project found that the species also uses the Colorado River in western Grand Canyon much farther upstream. Other findings include the presence of juvenile fish in the Lake Mead inflow area indicating recruitment, larval fish above Lava Falls indicating spawning and possible recruitment in the river reach, and long-distance movement of adult razorback suckers throughout Lake Mead and western Grand Canyon.

Because the capture of larval fishes helps to identify where spawning takes place, the duration of spawning activities, habitat use, and availability and fish community dynamics, Reclamation funded additional research for larval fish surveys in the lower reaches of Grand Canyon. For the last four years, biologists have sonic-tagged adult razorback suckers to track movements and possibly locate spawning aggregations. Evidence indicates razorback sucker had migrated upstream from Lake Mead and had spawned in Grand Canyon during February and March of each year. Larvae were found above Lava Falls, which suggests that spawning is occurring somewhere above that point in the river. This is encouraging news for native fish restoration because the detection of these larval fish indicates that razorback suckers may be naturally reproducing in an area where the species had not been detected in more than 20 years.

Tribal Activities

Reclamation continued to fund five American Indian Tribes (Hopi, Hualapai, Pueblo of Zuni, Kaibab Paiute, and the Navajo Nation) to participate and provide their perspectives to the AMP. They identify and monitor traditional cultural properties and provide annual reports detailing their activities, findings, and monitoring of data.

Several government-to-government consultations with interested tribes were conducted throughout the year, and additional staff level meetings and conference calls with interested tribes were also held.

In addition to the high-flow experimental release and consultations for the LTEMP EIS, Reclamation continues to conduct government-to-government consultations with American Indian Tribes as part of the AMP on operations of Glen Canyon Dam and activities of the AMP in services of its responsibilities, including those under §106 of the National Historic Preservation Act, Executive Order 13175, Secretarial Order 3206, and the November 5, 2009, Presidential Memorandum on Tribal Consultation.

Reclamation continued implementation of two memoranda of agreement (MOA) to mitigate for adverse effects under § 106 of the National Historic Preservation Act for the High-Flow Experimental Protocol and non-native fish management described above. The consultation process leading to execution of these two MOAs included consensus determination of eligibility of the Grand Canyon as a traditional cultural property for several tribes, at their request. Reclamation, in collaboration with other stakeholders, also completed a new Programmatic Agreement for the operation of Glen Canyon Dam pursuant to the GCPA that is consistent with the LTEMP.

Reclamation will complete a Historic Preservation Plan as required by the LTEMP Programmatic Agreement in fiscal year 2018.

Other Activities

Grand Canyon National Park employs a permitting specialist and staff who review all proposals for projects to be completed in the park. Reclamation funds these positions to offset the park's administrative burden from AMP activities. Permitting activities completed in 2017 are described by the NPS in a later section of this report.

NPS

Three units of the NPS (Glen Canyon National Recreation Area, Grand Canyon National Park, and Lake Mead National Recreation Area) provide support for various operations. In 2017, staff from the Intermountain Regional Office, along with staff from both Glen Canyon National Recreation Area and Grand Canyon National Park, continued working with Reclamation and the other AMP agencies on reviewing information for a potential HFE. Lack of sediment was a major resource concern and Interior staff concurred with a recommendation to not have a fall HFE in 2017. Staff from the NPS continued to work with Reclamation on implementation of the LTEMP ROD, including drafting proposals for programs directly related to environmental commitments to cultural resources, endangered species, avifauna, and vegetation management.

The NPS began working on a new environmental assessment to address high-risk non-native species below Glen Canyon Dam. The plan, called the Expanded Non-Native Aquatic Species Management Plan, will evaluate the use of additional management tools for minimizing or eliminating high-risk species in the Colorado River and tributaries in Glen Canyon National Recreation Area and Grand Canyon National Park that were not addressed in either the LTEMP or NPS Comprehensive Fisheries Management Plan.

LTEMP EIS

Since the completion of the LTEMP EIS in late 2016, the NPS, working with Reclamation and other Interior partners, has continued to work on implementation of the action and specific resource management recommendations. Development of proposals for fisheries, archaeological monitoring and mitigation, vegetation monitoring and mitigation, and avifauna monitoring were priorities for 2017.

Archaeological/Cultural Resources

Grand Canyon National Park: Field work in 2017 consisted of an assessment river trip with GCMRC and USGS scientists to reassess drainages documented in 2000 to determine if dam operations have resulted in landscape changes. In addition to drainages, condition assessments occurred at 65 river corridor archaeological sites as part of ongoing Colorado River Management Plan implementation. Staff began working with Reclamation and other signatories on Stipulation IV of the LTEMP Programmatic Agreement and development of a Historic

Preservation Plan. Staff have drafted components of chapters related to previous preservation and treatment work along the river corridor.

The Zuni Cultural Resource Advisors and NPS archaeologists continue to document tribal values related to appropriate stabilization techniques. The tribe and the NPS will continue to monitor the success of stabilization at one specific river corridor location.

Glen Canyon National Recreation Area: Staff from Glen Canyon National Recreation Area prepared a long-term monitoring and protection plan for the cultural resources found in the Glen Canyon reach. This plan will remain in draft form until the Historic Preservation Plan is completed so that important components from that plan can be included. The NPS also scheduled and hosted raft trips for the interested tribes in conjunction with ethnographic reports for the Glen Canyon reach. One highlight was the opportunity for a group of Hopi women to participate in a raft trip and to provide the female perspective for a number of cultural sites that were visited. Glen Canyon National Recreation Area staff also continued to support the GCMRC's monitoring of dam related topographic changes at select cultural sites.

Tribal Consultation

In 2017, the NPS continued to participate in consultation meetings with the various tribes who are directly involved in the AMP and other Colorado River related programs. The NPS's Grand Canyon National Park and Glen Canyon National Recreation Area continued discussions with tribes and incorporated tribal perspectives into implementation of the NPS's Comprehensive Fisheries Management Plan and initiation of the Expanded Non-Native Aquatic Species Management Plan. Tribal advisors were consulted on specific monitoring and mitigation protocols relative to Grand Canyon National Park's Colorado River Management Plan implementation. Included in the mitigation efforts related to the NPS Comprehensive Fisheries Management Plan was the delivery of fish removed from the system to tribal communities and aviaries (at Zuni and Navajo).

The NPS worked with Reclamation to consult with interested tribes involved in the LTEMP. Consultation is government-to-government and includes all tribes who are interested in the planning effort regardless of their role as a cooperating agency for the EIS. They also worked extensively together on the draft Historic Preservation Plan, the implementing document of the 2016 Programmatic Agreement associated with the final EIS and ROD.

Again in the fall of 2017, Glen Canyon National Recreation Area and Grand Canyon National Park engaged in consultations with the Hopi Tribe, Hualapai Tribe, Kaibab Paiute Tribe, Navajo Nation, and the Pueblo of Zuni regarding the second green sunfish invasion in the Upper Slough of Glen Canyon National Recreation Area. Tribes suggested several actions that were implemented and that facilitated resolution of the problem.

Glen Canyon National Recreation Area staff traveled to and engaged in consultation with the Hopi Tribe, Kaibab Paiute, Navajo Nation, and Pueblo of Zuni to discuss next steps in the planning for management of non-native aquatic species as they show up in the Colorado River below Glen Canyon Dam. The insights and concerns of each tribe provided valuable information

on next steps in addressing a significant resource threat while taking into account the tribal perspectives.

A number of ethnographic field trips were conducted with tribal representatives to visit the Glen Canyon reach sites in 2017 to allow for informed decisions to be made on how best to monitor and protect the cultural resources impacted by dam operations. Funding for that work was provided by Reclamation as part of their section 106 responsibilities associated with the operation of Glen Canyon Dam, and one of the purposes being to help inform the mitigation of archaeological sites that are affected by dam operations within Glen Canyon. This ethnographic work also helps the NPS and Reclamation to understand the contemporary and cultural significance of archaeological sites within the Glen Canyon reach. It will also help inform the monitoring and mitigation of archaeological sites that are affected by dam operations within Glen Canyon during the planning process for the Historic Preservation Plan.

Humpback Chub Translocation and Fisheries Management

In 2017, Grand Canyon National Park continued implementation of the Comprehensive Fisheries Management Plan for native fish within Grand Canyon National Park 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 (thought to have been extirpated until 2014), translocations and/or monitoring of endangered humpback chub to Havasu Creek, and the removal of non-native fishes threatening endangered and native fish in Bright Angel Creek and the Bright Angel Creek inflow area of the Colorado River. The recovery of habitat in Shinumo Creek following a fire and flood was also monitored.

Monitoring of humpback chub translocation efforts in 2017 allowed the NPS to document the successful establishment of a reproducing population of the endangered species in Havasu Creek through translocations. Humpback chub that were produced as a result of spawning in Havasu Creek were found to have grown to maturity.

A panel of experts organized by the AMP Science Advisors reviewed the five-year status report on progress toward reducing the threat of non-native fish in Bright Angel Creek to native and endangered fishes. Based on the reduction in non-native fish and expansion of native fish, the panel determined that the non-native trout had been successfully reduced to a level that would allow for the translocation of humpback chub.

Invasive species monitoring continued in 2017 in Glen Canyon with emphasis on invasive fish and quagga mussels. Quagga mussel colonization at depth in the river within Glen Canyon is increasing, but remains very patchy. The non-native brown trout population in Glen Canyon continued to increase; brown trout are an undesirable, high-risk non-native predator targeted for mechanical removal in the Comprehensive Fisheries Management Plan that may threaten the rainbow trout fishery in Glen Canyon and native fish in Grand Canyon. The AMP convened an interagency workshop to assess potential causes of the expansion as well as to assess risks to the rainbow trout fishery and endangered species. A final report, including an assessment of the

efficacy of potential management actions to reduce brown trout, is expected to be finalized in 2018.

The angler catch rate of rainbow trout within Glen Canyon declined in the lower 3.5 miles of the Colorado River. The Arizona Game and Fish Department (AGFD), in coordination with the FWS, is planning to stock sterile rainbow trout at this location. Any stocking would be consistent with the NPS's Comprehensive Fisheries Management Plan, including the development of an implementation plan for stocking that would minimize risk to endangered species in Grand Canyon.

Wildlife Surveys and Monitoring

Grand Canyon National Park: In 2017, Grand Canyon National Park continued wildlife monitoring and surveys of several species. These efforts included the continuation of a desert bighorn sheep study, monitoring and surveys for ESA listed Mexican spotted owls and California condors, and long-term monitoring and surveys for bats.

The desert bighorn sheep study is in its fifth year, partnering with the USGS and Oregon State University, and continues to refine and determine habitat connectivity throughout the river corridor, genetic diversity and population dynamics, predator-prey dynamics, and evaluate disease impacts. Surveys for Mexican spotted owls continued to document the presence of breeding pairs and refine the numbers and locations of protected activity centers. Collaborative efforts between Grand Canyon and the Peregrine Fund continued to track breeding success and survival rates of California condors. Collaborative efforts between Grand Canyon and AGFD continued to collect baseline data on bat diversity, seasonal activity patterns, cave hibernacula, and conduct surveillance for White Nose Syndrome (which has not arrived yet to Grand Canyon).

Glen Canyon National Recreation Area: In 2017, Glen Canyon National Recreation Area staff and partners worked on great blue heron, waterfowl, and raptor surveys along the 16-mile reach below Glen Canyon Dam. Work continued on monitoring aquatic/riparian invertebrates and terrestrial vertebrate populations utilizing the open water habitat at Leopard Frog Marsh.

Bald eagle surveys were conducted in January 2017 on the Colorado River and Lake Powell. Continuing bat monitoring efforts were also implemented both above and below the dam in order to identify the bat species using the Colorado River corridor.

Monitoring for impacts from quagga mussels both above and below the dam and for invasive fish and other invasive species is ongoing.

Vegetation Management/Exotic Species Removal

Grand Canyon National Park: In 2017, the NPS continued to implement exotic plant species removal at priority sites, expand plant collection and propagation efforts in preparation for future watershed restoration projects, and provide hands-on stewardship opportunities. The NPS also maintained native plants and removed exotic species at Granite Camp as part of a pilot riparian

restoration project. Specific accomplishments along the river corridor in Grand Canyon National Park were:

- Continued the first riparian restoration project in the river corridor at Granite Camp (RM 94) through site maintenance and outreach to project partners.
- Continued collection and propagation of riparian plant species for mortality replacement plantings at Granite Camp and other future riparian restoration projects.
- Removed 1,960 tamarisk (*Tamarix sp*.) plants and 727 camelthorn (*Alhagi pseudalhagi*) plants from the Granite Camp restoration site.
- Initiated planning with The Arboretum at Flagstaff for the second riparian restoration project at Cardenas Camp.

Glen Canyon National Recreation Area: In 2017, the NPS, partners, and volunteers continued invasive plant management efforts, native plant restoration activities, and vegetation monitoring efforts along the Colorado and Paria rivers below Glen Canyon Dam. Specific accomplishments in Glen Canyon National Recreation Area were:

- Continued to water and restore native upland plants at a number of sites along the roadways into Lees Ferry.
- Continued native seed collection and plant propagation planning efforts to begin riparian plant restoration in important habitat areas in the Glen Canyon reach.
- Controlled, mapped, and/or monitored for the following invasive non-native species infestations including Russian olive, tamarisk leaf beetles, Ravenna grass, and Sahara mustard.

Research Review and Permitting

The Grand Canyon's Research Office continues to have one of the largest research and collection permitting programs within the NPS. There are more than 200 researchers that are listed as either principal or co-principal investigators presiding over current studies. In 2017, the Grand Canyon's Research Office received 21 river trip applications to fulfill obligations under the AMP. The GCMRC was issued 11 research and collection permits and 21 stand-alone river permits, totaling 4,599 user days. Three tribal research permits with corresponding river trips were permitted for the Hopi, Hualapai, and Paiute tribes, totaling 571 user days. Overall, 5,170 user days were spent on the river conducting AMP-related research.

For each GCMRC and tribal permit, an interdisciplinary team of technical experts reviewed and provided comments on the research proposal or logistics and assistance was given to the principal investigator in completing the minimum requirement analysis and related compliance documents.

Additionally in 2017, Grand Canyon Science and Resource Management staff participated in AMP-related meetings and river trips; attended and participated in GCMRC's annual reporting meeting; and attended Glen Canyon Dam TWG meetings, knowledge assessment workshops,

and other meetings with the GCMRC and TWG. These discussions are integral to future collaborations and allow for shared input and an increase in NPS involvement in the AMP.

Outside of the AMP, the research office continued to review proposals, coordinate efforts, and provide permitting guidance as needed for all GCPA projects in 2017. An additional 43 research permits were issued to independent or university researchers and logistical planning was provided to various disciplines including vegetation baseline monitoring, geomorphology, terrestrial remote sensing, and soundscape monitoring. Grand Canyon National Park anticipates continuation of research and permitting activities in 2018 at similar levels as 2017.

The Glen Canyon National Recreation Area continued administration of nearly 15 research permits associated with the AMP between Glen Canyon Dam and the Paria River. A new permit for research on green sunfish control options was added. The NPS anticipates continuation of research and permitting activities in 2018 at similar levels as 2017.

Resource Monitoring and Mitigation

In 2017, Grand Canyon National Park began the process of integrating monitoring of Colorado River campsites with all backcountry campsite monitoring. The opportunity presented itself when the strategic pause in Grand Canyon NPS river operations allowed staff to review and revise Colorado River Management Plan methods and create a final, written protocols document. At the same time, a plan for adaptive management of day and overnight use in the Grand Canyon backcountry, tied to drafts of the Backcountry Management Plan, was in development. Methods for monitoring backcountry campsites were aligned with Colorado River Management Plan campsite monitoring in ways that allowed integration of the two into a single database with shared fields.

The Glen Canyon National Recreation Area continued multi-faceted efforts with the State of Arizona to prevent aquatic invasive species transport to and from Lake Powell and Lees Ferry. Aquatic invasive species (including New Zealand mudsnails, didymo, and quagga mussels) present extreme potential impacts to a wide range of GCPA associated resources. The NPS continued the use of cameras at several localities to monitor terrace erosion and changes related to dam operations and HFEs.

Greater Grand Canyon Landscape Assessment

Grand Canyon National Park staff completed the Greater Grand Canyon Landscape Assessment in October 2016, with publication put on hold in 2017 due to staffing limitations. An interdisciplinary team of NPS experts, agency partners, scientists, and other groups and individuals completed the assessment and identification of resource conditions and trends and prioritization of conservation needs facilitating ecosystem-based stewardship. The collaborative efforts of the previous four years by NPS, Northern Arizona University, and numerous other partners (including federal and state agencies, tribes, universities, non-profit organizations, and special interest groups) came to fruition and the data for many of the focal resources has been synthesized and is being used to develop spatial layers to assist in subsequent analyses. The document is in the final editing phase and publication is expected to occur in late 2018. This report will serve as a baseline for current resource conditions and help guide park planning and

decision making for the future.

FWS

The FWS has participated in the LTEMP as a cooperating agency and for the development of alternatives. With the finalization of LTEMP, efforts have transitioned into assisting with implementation. The FWS continued to cooperate with the NPS regarding the Comprehensive Fisheries Management Plan, which guides NPS activities for native and non-native fish in Grand Canyon National Park and Glen Canyon National Recreation Area. The FWS also cooperates with the AGFD regarding recreational angling in the same area. The FWS will continue to participate in the AMWG, TWG, and various ad hoc groups and other related assignments. The FWS is also engaged with Grand Canyon National Park in the development of resource conditions for the Greater Grand Canyon Landscape Assessment process.

In 2017, the FWS conducted four monitoring trips on the Little Colorado River to generate population estimates for humpback chub and to monitor trends of other native fishes. Since 2006, the Little Colorado River population of humpback chub in Grand Canyon has significantly increased in size. Population estimates in 2017 returned to near 2014 levels reversing declines seen in 2015 and 2016. The FWS conducted one trip on the Little Colorado River to monitor the success of upstream translocations of humpback chub within the Little Colorado River. These translocation efforts have been successful with humpback chub experiencing high growth rates and high survival in this upper portion of the river. In 2017, the FWS continued this translocation effort, moving an additional 315 humpback chub upstream of Chute Falls.

The FWS has continued to work collaboratively with the GCMRC and Grand Canyon National Park in the collection and transport of young humpback chub for translocation into Havasu Creek. No larval humpback chub were collected in 2017 for grow-out and translocations.

The FWS conducted aquatic invasive species surveillance surveys in the Little Colorado River watershed. These surveys discovered three aquatic invasive species previously unknown from the watershed and reinforced watershed connectivity with fish upstream. The three new species included white crappie, smallmouth buffalo, and bigscale logperch.

The FWS, in collaboration with the GCMRC and NPS, continues to develop and refine a monitoring program to effectively sample mainstem aggregations of humpback chub in the Colorado River in Grand Canyon. In 2017, the FWS and GCMRC conducted one sampling trip to estimate the population size of humpback chub in these aggregations. Large numbers of juvenile and adult humpback chub were collected in western Grand Canyon and appear to represent a growing downstream population expansion.

USGS

In 2017, the GCMRC continued to serve in its role as the primary science provider to the AMP. The GCMRC's primary activities during 2017 were: (1) conducting an annual reporting meeting that summarized findings from the previous year's research and monitoring activities and summarized knowledge-to-date concerning the Colorado River ecosystem; (2) developing a

three-year Budget and Work Plan encompassing fiscal years 2018-2020; (3) implementing the third year of a three-year Budget and Work Plan encompassing fiscal years 2015-2017; (4) maintaining a stream flow and sediment transport measurement and internet-based real-time reporting program that was the foundation for planning a potential November 2017 HFE; (5) analysis of those data so as to inform dam and river management activities in the months immediately before a potential HFE; (6) collection and reporting of data describing resource conditions following the November 2016 HFE; (7) collection and reporting of native and non-native fish population data in support of management decisions regarding recovery of humpback chub, maintaining the Lees Ferry sport fishery, and non-native fish control; and (8) monitoring key cultural resources and physical processes that may affect them. Additionally, the GCMRC conducted numerous field and laboratory studies and provided logistical support for river trips and other field activities and provided scientific support for implementation of the LTEMP EIS.

Knowledge Synthesis

In January 2017, the GCMRC conducted an annual reporting meeting with AMP stakeholders during which results from research and monitoring in key resource areas in Glen and Grand canyons from the previous year were presented by scientists from the GCMRC and cooperating agencies as well as tribal representatives. The foci of the January meeting were biology, ecology, hydrology, sediment transport, geomorphology, cultural resources, and recreation resources. All materials presented at the workshops were made available in electronic postings at the GCMRC and Reclamation websites.

Development of a Three-Year Budget and Work Plan for Fiscal Years 2018-2020

In close cooperation with AMP stakeholders, GCMRC developed a three-year Budget and Work Plan for fiscal years 2018-2020. Similar to the 2015-2017 Budget and Work Plan, the new plan was organized into a relatively small number of focused projects. Key topics of study include hydrology, sediment transport, geomorphology, fisheries, aquatic ecology, riparian vegetation, cultural resources, and socioeconomics. Such plans are tentative and subject to change during the annual Budget formulation process.

Implementation of a Three-Year Budget and Work Plan for Fiscal Years 2015-2017

In close cooperation with the AMP stakeholders, the GCMRC implemented the third year of a three-year Budget and Work Plan for fiscal years 2015-2017. The plan is organized into a relatively small number of focused projects. Key topics of study include hydrology, sediment transport, geomorphology, fisheries, aquatic ecology, riparian vegetation, cultural resources, and socioeconomics.

Implementation of Stream Flow and Sediment Measurement Program in Support of the High-Flow Experimental Protocol and LTEMP ROD

The periods from December 1, 2016, to June 30, 2017, and July 1 to November 30, 2017, mark the “sediment accumulation periods” for spring and fall HFEs, respectively, as defined under the

High-Flow Experimental Protocol that was initially adopted by the Secretary in 2012 and carried forward into the 2016 LTEMP EIS ROD. The High-Flow Experimental Protocol necessitates the estimation in real time of sand delivery from the Paria River and sand retention in Marble Canyon in the months immediately prior to the HFE. The GCMRC worked in collaboration with the Arizona and Utah Water Science Centers of the USGS to measure suspended-sediment transport and to process field samples in the GCMRC sediment lab. Telemetered data from remotely deployed instruments were shared in real time on the GCMRC website while data from physical samples were shared with Reclamation via the GCMRC website on a bi-weekly basis in an unmatched effort to provide sediment data in a near real-time format for HFE planning purposes.

The GCMRC measured that between 150,000 and 184,000 metric tons of sand were supplied to the Colorado River by the Paria River between December 1, 2016, and June 30, 2017, and that between 496,000 and 548,000 metric tons of sand were exported from Marble Canyon during this same period. The GCMRC also measured that between 247,000 and 301,000 metric tons of sand were supplied to the Colorado River by the Paria River between July 1 and November 30, 2017, and that between 208,000 and 230,000 metric tons of sand were exported from Marble Canyon during this same period. Thus, during the spring accumulation period (December 1, 2016, through June 30, 2016) net erosion of sand from Marble Canyon occurred, and during the fall accumulation period (July 1 through November 30, 2017) only minimal sand accumulation in Marble Canyon occurred. Therefore, the amounts of newly delivered sand retained in Marble Canyon during the spring and fall 2017 sediment accumulation periods were inadequate to trigger HFEs.

Analyses of Sediment Transport Data to Inform HFE Planning and Design

The GCMRC scientists evaluated sediment transport and sediment mass balance data and made recommendations to Reclamation concerning whether or not to conduct an HFE due to limited sediment inputs from the Paria River. No HFE was conducted in 2017 due to inadequate sediment inputs.

Implementation of a Plan to Evaluate HFE Effects

The GCMRC utilizes annual topographic surveys and a network of field time-lapse cameras to evaluate the effects of HFEs and other flows on sandbars throughout the Colorado River ecosystem. Scientists were sent into the field in February 2017 to collect photographic data and recover gaging station data following the November 2016 HFE. Analysis of images indicated that the November 2016 HFE resulted in substantial deposition at 56 percent of the monitoring sites and substantial erosion at 12 percent of the sites. Three months following the HFE, only 15 percent of the bars were still larger than the pre-HFE condition. By October 2017, 11 months after the HFE, nine percent remained larger than before the 2016 HFE, and 16 percent of the sites were smaller. The remaining sites were approximately the same size as they were before the 2016 HFE. Sediment inputs in 2017 were insufficient to trigger an HFE in fall 2017 and preliminary results indicate erosion occurred at most monitored sandbars as a result of normal dam operations (e.g., daily variation due to hydropower load-following flows) in water year 2017. The most recent topographic surveys of long-term monitoring sites from fall 2017 (water

year 2018) indicate sandbars increased in size during the first five years of implementation of the High-Flow Experimental Protocol.

In addition, rainbow trout populations and the aquatic food base in Glen Canyon were sampled before and after each of the November 2012, 2013, 2014, and 2016 HFEs to evaluate any effects on the aquatic ecosystem. Results indicate that fall HFEs do not trigger downstream movement of rainbow trout or affect rainbow trout growth rates. Rainbow trout abundance in Glen Canyon did decline substantially over the period that included the November 2012, 2013, and 2014 HFEs and also through 2015. These changes appear to be related to an overabundance of young trout produced in water year 2011 and a limited aquatic food base rather than any effect of fall HFEs. The abundance of young rainbow trout increased dramatically in 2016 and 2017 suggesting a recovery of the Glen Canyon rainbow trout population is underway. Catches of non-native brown trout have been increasing in Glen Canyon coincident with the implementation of the High-Flow Experimental Protocol with evidence of spawning in 2015 and 2016. The influence of fall HFEs on increases in this fish-eating predator are unknown, but is a topic of ongoing discussion among scientists and managers.

Results from monitoring also suggest that the aquatic food base only responds weakly to fall HFEs. Sampling before and after these fall HFEs demonstrates that the invertebrate assemblage is still dominated by New Zealand mudsnail, an invasive species, and tubificid worms and amphipods. These observations concerning fall HFEs stand in stark contrast to the dramatic change in the aquatic food base observed following the March 2008 HFE when unpalatable tubificid worms and New Zealand mudsnails declined sharply and abundance of high-quality aquatic insect prey increased dramatically.

Presentations concerning the effects of recent HFEs were given at GCMRC's January 2017 annual reporting meeting. Additional information about the effects of these HFEs was presented at a AMP meeting in February 2017.

Fisheries Information in Support of Non-Native Fish Control Environmental Assessment and LTEMP ROD

The GCMRC conducted monitoring of native and non-native fish populations initially in support of Reclamation's non-native fish control environmental assessment and its associated BO and then transitioned to support for the LTEMP ROD and its associated BO for endangered humpback chub. Both BOs identify several triggers which, if met, require management actions to be taken to protect humpback chub. The non-native fish control environmental assessment (EA) BO only identified actions to reduce non-native fish populations in an effort to protect humpback chub whereas the LTEMP ROD biological opinion includes two tiers of possible actions. The first specifies actions to benefit humpback chub directly and the second looks to reduce non-native fish populations. Information provided by the GCMRC for specific triggers included the abundance of juvenile, sub-adult, and adult humpback chub and the abundance of

non-native rainbow trout and brown trout in the Colorado River near the Little Colorado River confluence.

The GCMRC and its cooperators generated estimates of the abundance of several life stages of humpback chub in the Little Colorado River itself and near its confluence with the Colorado River, as well as survival rates of juvenile humpback chub in this latter area. None of the triggering criteria for humpback chub or trout were reached in 2017. Sub-adult humpback chub abundance in the Little Colorado River was below the trigger level identified in the 2011 BO. Sub-adult and adult humpback chub abundance estimates and juvenile humpback chub survival rates were above trigger levels and non-native trout abundance remained below trigger levels, so no additional actions to benefit humpback chub or control non-native fish abundance were required or implemented.

As in 2015 and 2016, green sunfish were detected in Glen Canyon downstream of Glen Canyon Dam in the summer of 2017. Similar to 2016, distribution was limited with these fish found only in a small pond. Green sunfish have rapid invasion and expansion potential and prey upon and compete with native fishes. Given these concerns and that the pond would be inundated by HFE flows, multiple mechanical removal efforts were conducted in and attempt to eradicate green sunfish from the area. Although numbers were reduced considerably, eradication by mechanical means was deemed unlikely. In October 2016, and again in 2017, in cooperation with the NPS and AGFD, the backwater was successfully treated with ammonia as an experimental piscicide to remove green sunfish. Green sunfish were successfully eradicated from this area ahead of the decision deadline for a potential HFE.

Cultural Resource Monitoring in Support of the High-Flow Experimental Protocol, LTEMP ROD, and AMP

The plan for monitoring geomorphic change at archaeological sites prepared in 2015 in consultation with Reclamation, the NPS, and American Indian Tribes affiliated with the AMP was implemented in fiscal years 2016 and 2017. In 2017, GCMRC scientists worked with Glen Canyon National Recreation Area staff to test the use of unmanned aerial technology for collecting measurements of surface topographic change at archaeological sites. In May 2017, GCMRC scientists worked with staff from Grand Canyon National Park to map and monitor archaeological sites in Grand Canyon using terrestrial lidar and other methods. GCMRC scientists completed and published a study that quantifies the effects of dam operations during the High-Flow Experimental Protocol (which began in 2012) on source-bordering aeolian dune fields that contain archaeological sites within Grand Canyon National Park.

The GCRMC also conducted a geographic information system analysis to investigate how past, current, and future variability in river flow due to dam operations interact with topography and vegetation within the river channel and riparian zone to influence the distribution and area of unvegetated river sand available for river runners to camp on, vegetation to potentially colonize, and for wind to potentially transport and redistribute within and outside of the active river channel and thereby help to preserve archaeological sites. In addition, GCMRC continued to assess changes in the distribution and abundance of riparian plant species that were traditionally valued and utilized by American Indian Tribes affiliated with the AMP.

Other Science Activities and Findings

In the course of its regular and mandated science monitoring and research activities, the GCMRC and its cooperators provided stakeholders and the AMP with other information including: (1) critical data concerning the status and trends of endangered humpback chub populations in the Colorado River downstream of Glen Canyon Dam as well as key tributaries; (2) status and trends of rainbow trout in Glen Canyon, Marble Canyon, and near the Little Colorado River confluence; (3) distribution and relative abundance of potentially harmful non-native fish species between Glen Canyon Dam and Lake Mead reservoir; (4) status and trends of the aquatic food base in the Colorado River ecosystem; and (5) status and trends of riparian vegetation.

The GCMRC was permitted for and provided logistics support for 22 mainstem river trips in 2017. Trips in 2017 included 16 AMP approved research and monitoring trips led by GCMRC or cooperating agency scientists that launched from Lees Ferry; one fisheries monitoring trip that launched from Diamond Creek; four tribal-led monitoring trips; and two youth "Partners-in Science" trips. Logistics support, including helicopter transport, was also provided for AMP-funded projects in the Little Colorado River conducted by the FWS, AGFD, and GCRMC. Five Little Colorado River trips were conducted in 2017 (same as in 2016) with each trip requiring two flight days, one to take crews into field camps along the river and one to retrieve them.

Tribal Activities

GCMRC staff met with tribal leadership and representatives to the AMP on several occasions in 2017 to consult about ongoing science projects and solicit input on ideas and opportunities for future collaboration as part of the fiscal year 2018-2020 Triennial Work Plan development process. The GCMRC economist met with tribal representatives in May to review and discuss implementation of a socioeconomic study that is being developed with tribal involvement. In August, the GCMRC economist met with the Hopi Cultural Resources Advisor Task Team and the Zuni Cultural Resources Advisory Team to review and test tribal surveys. In November, the GCMRC Chief and GCRMC staff met with Hualapai cultural center staff to discuss technical assistance needed by the tribe with an archival project funded by Reclamation. In December, the GCMRC economist participated in two Navajo Agency Council meetings, receiving support for implementation of tribal surveys.

2018 OPERATIONS

BIA

In water year 2018, the BIA will continue to take an active role in supporting stakeholder tribes related to the AMP. The BIA will participate in meetings concerning the Tribal Consultation Plan, the LTEMP Programmatic Agreement, pre-meetings with tribal representatives prior to AMWG meetings, and continue to participate in various ad hoc groups regarding tribal, cultural, and natural resource issues and concerns. The BIA will continue to be involved with any future HFE or experimental releases from Glen Canyon Dam as staffing permits. The BIA will

coordinate with, and if necessary meet with, Interior's Tribal Liaisons to facilitate stakeholder tribe participation in various aspects of the AMP.

Reclamation

Water Operations

The operation of Glen Canyon Dam is described in a set of documents relating to the use of the waters of the Colorado River, which are commonly and collectively known as the "Law of the River." The 2007 Interim Guidelines (Guidelines) became part of this collection, which set the operations of Lake Powell and Lake Mead according to the strategy set forth in section 6 of the Guidelines. On December 15, 2016, the ROD for the Glen Canyon Dam LTEMP was signed by the Secretary. The LTEMP provides alternative operating hydrographs developed for different hydrological year classes. These monthly release volumes are found in Attachment B to the ROD. The LTEMP monthly release volumes will be used in conjunction with Guidelines operations between October 1, 2017, and September 30, 2018 (water year 2018).

Releases from Lake Powell in water year 2018 reflect consideration of the uses and purposes identified in the authorizing legislation for Glen Canyon Dam and will be consistent with the 2016 LTEMP ROD. As of August 15, 2018, the observed and projected monthly release volumes for water year 2018 are displayed in Table 2. The end of water year 2018 elevation for Lake Powell is projected to be 3,595 feet.

Table 2. Lake Powell Monthly Release Volumes
Water Year 2018

Month	Monthly Release Volumes (MAF)
October 2017	0.640
November 2017	0.630
December 2017	0.740
January 2018	0.860
February 2018	0.730
March 2018	0.800
April 2018	0.705
May 2018	0.705
June 2018	0.760
July 2018	0.860
August 2018**	0.900
September 2018**	0.670
Total Releases**	9.000

** = projected release

Under the LTEMP HFE Protocol, high-flow experimental releases from Glen Canyon Dam are timed to occur following sediment inputs to the Colorado River from downstream tributaries to maintain and improve beaches and sandbars and associated habitat. HFEs may be conducted in the fall or the spring[2] when conditions warrant. GCMRC scientists and Reclamation modelers considered cumulative sediment inputs from July 1 through midnight October 9, 2017. Based on these data it was determined that there was not sufficient sediment to support implementing an HFE at Glen Canyon Dam during the fall 2017 planning window; therefore an HFE was not implemented during the fall of 2017 (water year 2018).
Reclamation will continue planning for high-flow experimental releases from Glen Canyon Dam in accordance with the LTEMP High-Flow Experimental Protocol.

LTEMP EIS

The LTEMP EIS and ROD provide a comprehensive framework for adaptively managing Glen Canyon Dam over the next 20 years consistent with the GCPA and other provisions of applicable federal law. The LTEMP includes a communication and consultation process that ensures input and consultation with stakeholders throughout the 20-year implementation. In 2018, Reclamation will continue a phased implementation of the LTEMP. Ongoing communication and coordination with stakeholders will continue.

Conservation Measures for Humpback Chub and Razorback Sucker

In 2018, ongoing conservation measures will continue as described above for 2017, and consistent with the prescriptions set forth under the LTEMP implementation. Reclamation will continue to provide funding to the GCMRC for aquatic and sediment research.

Tribal Activities

In 2018, Reclamation plans to continue to provide funding to the GCMRC and NPS for cultural research and will also continue to fund the five American Indian Tribes in the AMP (as described above for 2017). The LTEMP Programmatic Agreement was finalized in September 2017. Under the new Programmatic Agreement, tribal and NPS monitoring activities will continue. In addition, a Historic Preservation Plan will be developed and implemented by September 2018. This plan will, among other activities, continue consultation with interested parties, identify mitigation measures to address any adverse effects to historic properties, and develop a cultural sensitivity training for all researchers.

Other Activities

In 2018, Reclamation plans to continue to fund Grand Canyon National Park for a permitting specialist and staff to review all proposals for projects to be completed in the park. Reclamation funds these positions to offset the park's administrative burden from AMP activities.
Reclamation also plans to continue to fund Grand Canyon National Park to conduct management actions that fulfill ESA compliance for the LTEMP EIS.

[2] Under the LTEMP HFE Protocol, spring HFEs will be considered after September 30, 2019. No spring HFEs will occur prior to water year 2020.

NPS

LTEMP EIS

Following the LTEMP ROD in 2016, LTEMP implementation of various components will continue in 2018. Budgeting, coordination, and experimental planning continue in collaboration with Reclamation, GCMRC, tribes, and other stakeholders and partners.

NPS staff will continue to work on implementation of the National Historic Preservation Act section 106 compliance program, working with all interested parties on updating plans and developing field review strategies. This work will be guided by the finalization of a Historic Preservation Plan.

Archaeological/Cultural Resources

Grand Canyon National Park: In 2018, work will include participating in tribal monitoring field sessions along the river. NPS Archaeological Sites Management Information System condition assessments will be conducted at 60 to 70 sites as part of the monitoring for the Grand Canyon Colorado River Management Plan. The NPS is proposing to conduct assessments to a selection of 50 high priority locations identified in previous Reclamation treatment documents as needed mitigations. The assessments will be conducted as part of the planning process outlined in the Historic Preservation Plan, scheduled for completion this fiscal year.

Glen Canyon National Recreation Area: In 2018, work will include progress in the development and evaluation of monitoring protocols for terrestrial and non-native fish resources to evaluate potential effects resulting from dam operations. The Expanded Non-Native Aquatic Species Management Plan EA is also scheduled to be completed in 2018. If funding and staffing are available in a timely manner, the initial efforts in site preparation for riparian habitat restoration plantings will occur. Glen Canyon will initiate research into photogrammetry monitoring at select cultural sites with help from a national intern program. Staff will also continue opportunistic monitoring around planned HFEs.

Tribal Consultation

In 2018, the NPS anticipates continued participation in consultation meetings with the various tribes who are directly involved in the AMP and other Colorado River related programs. The Grand Canyon National Park and Glen Canyon National Recreation Area will continue discussions with tribes to incorporate tribal perspectives into implementation of the NPS's Comprehensive Fisheries Management Plan and the new Expanded Non-Native Aquatic Species Management Plan, expected to be completed by late 2018. Tribal advisors will continue to be consulted on specific monitoring and mitigation protocols relative to the Colorado River Management Plan implementation.

The Grand Canyon National Park anticipates working with the Pueblo of Zuni and external partners on projects to better protect important resources along the Colorado River. Specific

efforts will be made with the Pueblo of Zuni relative to creating a "buffer" zone near the confluence of Bright Angel Creek and Ribbon Falls Creek. This zone will incorporate specific removal techniques including use of nets and elimination of electrofishing in that area. Additional crew training will occur with representatives from Zuni to discuss specific concerns.

Park staff anticipates working with representatives from Traditionally Associated Tribes to gather information on the salt mines located along the river downstream of the Little Colorado River confluence. The NPS will continue to work with Reclamation to consult with interested tribes involved in the LTEMP.

In continuance of the 2016-2017 efforts with the Hopi Tribe, Hualapai Tribe, Kaibab Paiute, Navajo Nation, and the Pueblo of Zuni, Glen Canyon National Recreation Area anticipates each of these tribes finalizing ethnographic reports for the Glen Canyon reach. These reports will then be compiled into one final report by NPS staff that will facilitate contextualization of the archaeological sites in the Glen Canyon reach. As stated above, the purpose of that work will be to help inform mitigation of sites adversely affected by dam operations and to provide the federal land manager with an understanding of tribal histories in that stretch of the river to facilitate informed and culturally sensitive land management.

Further, Glen Canyon National Recreation Area, in partnership with Grand Canyon National Park and the NPS Intermountain Region, will conduct ongoing consultations relative to the Expanded Non-Native Aquatic Species Management Plan EA.

Humpback Chub Translocation and Fisheries Management

In Grand Canyon, implementation of the Comprehensive Fisheries Management Plan will continue into 2018. These efforts will include monitoring of translocated endangered humpback chub in and around Havasu and Shinumo creeks, and the continued removal of non-native fishes threatening endangered and native fish in Bright Angel Creek and the Bright Angel Creek inflow area of the Colorado River. On the recommendations of an expert panel, translocation of humpback chub will be initiated in Bright Angel Creek. The recovery of Shinumo Creek will continue to be monitored for the suitability of humpback chub translocation in the future. Collaboration with Reclamation, the FWS, GCMRC, and others will continue on all fisheries projects leading to well integrated projects.

In Glen Canyon, monitoring for invasive species, especially invasive fish, will continue with partners in 2018. Quagga mussel colonization monitoring will continue. In 2017, the NPS began a public planning process for the development of an expanded non-native fisheries management plan that will analyze various alternatives for suppressing or eradicating newly expanding populations of non-native fish threatening resources within NPS units downstream of Glen Canyon Dam. Alternatives considered during the planning process will include fisheries management tools that were not included in the 2013 NPS Comprehensive Fisheries Management Plan. The plan is expected to be finalized in late 2018.

Green sunfish populations, especially in the backwater areas, will be monitored carefully with partners in 2018 while long-term solutions are sought and investigated. A series of metal fish screens

were installed in the spring of 2017 to prevent sunfish from accessing, and thereby reproducing in the Upper Slough backwater area. Monitoring will occur and especially following any HFEs. Rental portable high volume pumps may be used following an HFE if any fish are found in the backwater slough prior to their being able to reproduce. These solutions are sought as an alternative to regular chemical treatments, which only treat the symptoms and are offensive to tribes and others.

Wildlife Surveys and Monitoring

Grand Canyon National Park: In 2018, Grand Canyon National Park will continue to monitor and investigate bighorn sheep mortalities and disease issues, and focus on producing resource selection and habitat models and generating a population estimate of bighorn sheep in Grand Canyon. Surveys and monitoring for ESA listed California condors and Mexican spotted owls will continue in 2018, as well as ESA surveys for Yuma clapper rails as identified in the LTEMP ROD. The long-term bat study will continue in 2018, focusing on captures (acoustically and mist netting) and White Nose Syndrome surveillance. Baseline data collection on select herpetofauna species will begin in 2018 to inform a graduate study beginning in 2019.

Glen Canyon National Recreation Area: In 2018, Glen Canyon National Recreation Area plans to continue programs related to aquatic/riparian invertebrates, bats, other terrestrial vertebrate populations, and northern leopard frog and ambersnail habitat enhancements.

Vegetation Management/Exotic Species Removal

In 2018, NPS staff will continue site maintenance and monitoring at Granite and Cardenas camps. Working with the GCMRC, NPS staff will continue integration of monitoring information into site preparation and planning for future mitigation efforts including creating a detailed species list and planting plans, plant material collection, monitoring transect establishment, ground water monitoring well installation, and site mapping. NPS staff also plan to implement the Colorado River Monitoring Program campsite monitoring and mitigation river trip in 2018. Work on this trip will include campsite monitoring using the Colorado River Management Plan rapid assessment tool, tamarisk beetle monitoring, exotic species removal, and vegetation pruning.

In 2018, the NPS (both Grand Canyon National Park and Glen Canyon National Recreation Area), partners, and volunteers will continue invasive plant management, native plant restoration, and vegetation monitoring activities along the Colorado and Paria rivers below Glen Canyon Dam. Both parks will also initiate riparian habitat restoration projects associated with the LTEMP EIS.

Research Review and Permitting

The NPS (both Grand Canyon National Park and Glen Canyon National Recreation Area) anticipates continuation of research and permitting activities in 2018 at similar levels as 2017. For each of the research projects in support of the GCPA, peer review of the proposals, evaluation of the need for National Environmental Policy Act compliance, and completion of

minimum requirement analysis will be completed. Updating of annual investigator reports will be done for each research permit and coordination with Reclamation will continue.

Resource Monitoring and Mitigation

In 2018, fieldwork will resume with the resumption of NPS and contracted river operations. A springtime monitoring trip is planned, with required stops at 48 core monitoring campsites and as many additional campsites as time allows. A fall mitigation trip is planned to address issues identified from monitoring data and information gained from other sources. In addition, a cooperative monitoring and mitigation program is in development which will use monitoring done by the GCMRC to inform NPS mitigation work where flow-related changes in vegetation and geomorphology degrade campsite conditions. Discussions were also begun with the Northern Arizona University Environmental Genetics and Genomics lab to determine the feasibility of combining future mitigation projects with field tests to address questions related to conservation genetics and community genetics.

Greater Grand Canyon Landscape Assessment

The report is in the final editing phase and publication is expected to occur in late 2018.

FWS

In 2018, the FWS will conduct four monitoring trips on the Little Colorado River to generate population estimates for humpback chub and other native fishes, and to also monitor the success of upstream translocations. The FWS will continue to work cooperatively with the NPS and Havasupai Tribe on monitoring Havasu Creek and collecting larval fish for additional translocations of humpback chub in the summer of 2018. Fish will be collected for translocations from the Little Colorado River and held at the Southwest Native Aquatic Resources and Recovery Center until they are large enough to be marked with a small tag. The FWS will continue to take the lead on developing a monitoring protocol for effectively sampling the mainstem aggregations of humpback chub and will conduct one sampling trip in 2018.

USGS

The major focus of the GCMRC's activities in 2018 is to continue to serve in its role as the primary science provider to the AMP by conducting the field and laboratory studies described in the fiscal years 2018-2020 Budget and Work Plan. Additionally, the GCMRC plans to continue providing real-time scientific data needed to implement the LTEMP. Specifically, the GCMRC will maintain its internet-based real-time reporting of stream flow, water quality, and sediment storage and transport in Marble and Grand canyons as well as continue providing estimates of the mass of sand, silt, and clay supplied to the Colorado River by the Paria and Little Colorado rivers and the mass of fine sediment stored in various parts of Marble and Grand canyons. Native and non-native fish population data will continue to be collected and reported on in support of management decisions regarding recovery of humpback chub, maintaining the Lees Ferry sport fishery, and control of non-native fish and aquatic invasive species. The GCMRC will continue monitoring and reporting on the condition of resources identified in the LTEMP

before and after HFEs or other flow experiments. The GCMRC will also work with Reclamation in refining experimental planning protocols.