



— BUREAU OF —  
RECLAMATION

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

**Water Years 2019 (Observed) to 2020 (Projected)**

**Colorado River Storage Project, Glen Canyon Unit  
Interior Region 7 – Upper Colorado Basin**



## **Mission Statements**

The Department of the Interior (DOI) conserves and manages the Nation's natural resources and cultural heritage for the benefit and enjoyment of the American people, provides scientific and other information about natural resources and natural hazards to address societal challenges and create opportunities for the American people, and honors the Nation's trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities to help them prosper.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

## Acronyms and Abbreviations

AGFD	Arizona Game and Fish Department
AMP	Adaptive Management Program
AMWG	Adaptive Management Work Group
BIA	Bureau of Indian Affairs
BO	Biological Opinion
CRSP	Colorado River Storage Project
DOI	Department of the Interior
EA	Environmental Assessment
EIS	Environmental Impact Statement
ESA	Endangered Species Act
FONSI	Finding of No Significant Impact
FWS	U.S. Fish and Wildlife Service
GCD	Glen Canyon Dam
GCMRC	Grand Canyon Monitoring and Research Center
GCPA	Grand Canyon Protection Act
GLCA	Glen Canyon National Recreational Area
GRCA	Grand Canyon National Park
HFE	High Flow Experiment
Interior	Department of the Interior
LIDAR	Light Detection and Ranging
LTEMP	Long-Term Experimental and Management Plan
MAF	million acre-feet
MOA	memorandum of agreement
NEPA	National Environmental Policy Act
NPS	National Park Service
Reclamation	Bureau of Reclamation
ROD	Record of Decision
Secretary	Secretary of the Department of the Interior
SWFL	southwestern willow flycatcher
TWG	Technical Work Group
USGS	United States Geological Survey
WAPA	Western Area Power Administration

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# Introduction

## Statutory Reporting Requirements

This report by the Department of the Interior (Interior) is submitted pursuant to the Grand Canyon Protection Act (GCPA) of 1992. Pub. L. No. 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.

GCPA § 1804(c)(2). This report provides an update from the last report, which was submitted on June 18, 2020 by Interior for years 2018 (observed) and 2019 (projected). The current report covers dam operations and other activities undertaken pursuant to the GCPA for 2019 (observed) and 2020 (projected). In this report, the timeframe for water and fiscal years is identical, October 1 through September 30.<sup>1</sup>

## Statutory Guidance Regarding Glen Canyon Dam Operations

Glen Canyon Dam was authorized for construction by the Colorado River Storage Project Act (CRSP) 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

in 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 GCPA § 1802(a). Congress also directed that such operations be undertaken

in 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

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<sup>1</sup> This report was finalized during 2021 water year. Notwithstanding the timing of finalization of this report, the format follows the direction of GCPA Section 1804(c)(2) and describes the 2020 operations as “projected.”

Act of 1968 that govern allocation, appropriation, development, and exportation of the waters of the Colorado River basin.

GCPA § 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.

## **Roles of Department of the Interior Bureaus**

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 Tribe, Hualapai Tribe, Pueblo of Zuni, Southern Paiute Consortium, 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.

### **Bureau of Indian Affairs**

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.

### **Bureau of 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).

## **National Park Service**

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 (GRCA) and Glen Canyon National Recreation Area (GLCA) 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.

## **United States Fish and Wildlife Service**

The FWS provides Endangered Species Act (ESA) conservation and associated consultation and recovery leadership with various stakeholders primarily to benefit five listed species located in the Colorado River: the humpback chub (*Gila cypha*), razorback sucker (*Xyrauchen texanus*), southwestern willow flycatcher (*Empidonax trailii extimus*), Yuma Ridgway's rail (*Rallus obsoletus yumanensis*), and Kanab ambersnail (*Oxyloma haydeni kanabensis*), as well as other relevant resource issues.

## **United States Geological Survey**

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 GRCA and GLCA. 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.

# 2019 Dam Operations (Observed) and Adaptive Management

## Bureau of Indian Affairs

In water year 2019, the BIA participated in pre-meetings with tribal representatives prior to the AMWG meetings, met with the Interior Tribal Liaisons in person and via monthly telephone calls to discuss tribal concerns, and participated in meetings regarding cultural and natural resources issues and concerns. Principal among tribal concerns for 2019 remains the importance of traditional cultural values. The tribes remain concerned with the mechanical removal of non-native fish in the Colorado River and were opposed to trout stocking at Lees Ferry by the Arizona Game and Fish Department (AGFD). The BIA continued to provide 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) and a spring macroinvertebrate production flow experiment, and continuing to work with the Interior Tribal Liaisons to maximize tribal consultation and involvement.

## Bureau of Reclamation

### Water Operations

The August 2018 24-Month Study projected the January 1, 2019, elevations of Lake Powell and Lake Mead to determine the water year 2019 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, 2019, reservoir elevations of Lake Powell and Lake Mead were projected to be 3,586.55 feet and 1,079.50 feet, respectively. Given these projections, the annual release volume from Lake Powell during water year 2019 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 2019 24-Month Study. The April 2019 24-Month Study was run with an 8.23 MAF annual release volume to project the September 30, 2019, 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 3,618.44 feet and 1,072.84 feet at Lake Mead. Since the projected end of water year elevation at Lake Powell was below the 2019 Equalization elevation of 3,655 feet but 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 2019. Under section 6.B.4, the Secretary shall balance the contents of Lake Mead and Lake Powell but shall release no more than 9.00 MAF and not less than 8.23 MAF from Lake Powell. Based on these guidelines, the annual release volume during water year 2019 was 9.00 MAF.



Under the Long-Term Experimental and Management Plan (LTEMP), the second macroinvertebrate production flows (also commonly referred to as “bug flows”) experiment was designed and conducted during May-August 2019. Bug flows are intended to increase the diversity and abundance of aquatic insects by improving egg laying conditions for these aquatic insects. Additional information on the background and benefits of the bug flow experiments can be found on page 17. Glen Canyon Dam releases were held steady on weekends in an attempt to increase production of aquatic insects.

The first HFE release under the LTEMP was successfully conducted during November 2018 (water year 2019). Reclamation released the maximum available capacity (38,100 cubic feet per second) during the experiment, which ran from November 5-8, 2018. Preliminary findings suggest that this HFE and the previous four HFE releases (under the HFE Protocol) 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 following these HFEs. Reports from the Grand Canyon white water rafting community have been positive on the improvement of beaches in Grand Canyon over this period as well.

The total annual release from Glen Canyon Dam in water year 2019 did not change as a result of the HFE. The monthly release volumes for water year 2019 are displayed in Table 1. The end of water year 2019 elevation for Lake Powell was 3,515.36 feet.

**Table 1. Lake Powell Monthly Release Volumes for Water Year 2019**

<b>Month</b>	<b>Monthly Release Volumes (in MAF)</b>
October 2018	0.625
November 2018	0.625
December 2018	0.740
January 2019	0.804
February 2019	0.804
March 2019	0.791
April 2019	0.791
May 2019	0.720
June 2019	0.765
July 2019	0.765
August 2019	0.900
September 2019	0.687
<b>Total Releases</b>	<b>9.000</b>

The ten-year total flow of the Colorado River at Lees Ferry<sup>2</sup> for water years 2010 through 2019 was 92.54 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.

### **Environmental Program Funding**

Several programs necessary to achieve environmental and ESA compliance for the continued operation of the CRSP have historically been funded with hydropower revenues generated by CRSP facilities. However, in fiscal year 2019, the Office of Management and Budget directed Western Area Power Administration to transfer \$23 million to the U.S. Treasury for repayment of original project construction costs and replacements, rather than following the historic practice explicitly authorized in Section 3 of PL 106-392, whereby CRSP power revenues were used for partially funding the environmental programs. Impacted programs included the Glen Canyon Dam Adaptive Management Program, Upper Colorado River Endangered Fish Recovery Program, San Juan River Basin Recovery Implementation Program, Consumptive Use Studies, and Quality of Water Program.

As a result of stakeholder outreach, then-Senator Hatch (Utah) sponsored an amendment to the Energy & Water Development Appropriations bill that addressed the issue for FY 2019; the programs were fully funded via additional appropriations rather than hydropower revenues. However, the resolution did not address future years, and it is unclear how the CRSP environmental programs will be funded in the future.

### **Long-Term Experimental and Management Plan (LTEMP) Environmental Impact Statement (EIS) and Record of Decision (ROD)**

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 implementation of the LTEMP EIS and ROD is to continue the successful experiments completed under the AMP. To date, one fall high flow experiment (2018) and two bug flow experiments (2018, 2019) have been implemented under the LTEMP.

### **Integrated AMP Stakeholder River Trip**

In 2019, Reclamation funded an integrated AMP stakeholder river trip. The objective of the trip was to provide an opportunity for AMWG members and AMP stakeholders to articulate their respective values, concerns and issues in a field setting. The river trip also provided the opportunity for AMWG members to visit the canyon and gain a greater understanding of AMP resources and issues. The 2019 trip started at Lees Ferry on July 25 and ended at Diamond Creek on August 2. Twenty-four stakeholders representing federal agencies, Colorado River Basin States, American Indian Tribes, and NGOs participated. Similar trips are planned every 2 or 3 years.

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<sup>2</sup> A point in the mainstem of the Colorado River one mile below the mouth of the Paria River.

## **Conservation Measures for Humpback Chub and Razorback Sucker**

From fiscal years 2009 through 2018, Reclamation has funded the NPS to remove non-native trout and intermittently translocate humpback chub into two tributaries: Shinumo Creek and Havasu Creek. In 2018, scientists determined that a five-year adaptive management action to remove non-native trout was adequately successful in Bright Angel Creek, and thus humpback chub were translocated there as well. These actions were implemented to fulfill: (1) conservation measures from the 2016 LTEMP Biological Opinion (LTEMP BO), and (2) recovery goals as defined by the FWS for establishing additional reproducing populations of humpback chub. These efforts are to provide additional refuge 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.

Translocations into Shinumo Creek that occurred from 2009 to 2013 were discontinued following a lightning-caused fire that burned 6,100 acres in the drainage and led to a series of ash-laden floods. These events flushed and scoured the aquatic fauna from the creek and greatly altered habitat conditions making the lower portion temporarily unsuitable for fish. Monitoring of Shinumo Creek has continued to determine the recovery and suitability of the habitat. Surveys indicate that the habitat has improved, and the area will continue to be evaluated for potential future humpback chub translocations.

Juvenile humpback chub have been translocated to Havasu Creek periodically since 2011. Two monitoring trips per year are conducted to determine abundance, annual survival, and growth estimates for the translocated humpback chub. Data indicates that the objectives of the translocations are being met. In addition, non-translocated and humpback chub less than 150 millimeters have also been captured. The occurrence of the smaller humpback chub indicates that there are 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 ensure the genetic diversity of the population.

In 2019, no humpback chub were translocated to the three tributaries due to insufficient numbers of larval fish collected in 2018. However, approximately 690 young-of-year humpback chub were collected for future translocations and hatchery support for the FWS Southwest Native Aquatic Resource and Recovery Center.

Monitoring has shown that abundance of adult humpback chub in the mainstem has significantly increased at all aggregations, as well as at some non-aggregation sites, since 2006. Humpback chub adults are currently abundant (> 12,000 adults) and expanding in range. Humpback chub translocations to Shinumo Creek and Havasu Creek have also contributed to the mainstem aggregations located at the tributary mouths. Other areas not associated with known aggregations were sampled the last several years and results indicate that humpback chub are more widely distributed in the mainstem than had been detected previously, particularly in the western Grand Canyon. This is likely the result of emerging habitat below Diamond Creek as Lake Mead recedes, warmer water temperatures, and low predator burden.

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 the termination of Grand Canyon at Pearce Ferry.

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 since the 1900s that razorback suckers occupy and are able to reproduce and recruit in Lake Mead, recent monitoring projects determined 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 fish 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 juvenile and larval fish surveys in the lower reaches of Grand Canyon. For the last five years, biologists have sonic-tagged adult razorback suckers to track movements and possibly locate spawning aggregations. Evidence indicates razorback suckers had migrated upstream from Lake Mead and had spawned in Grand Canyon during February and March of each year. Larvae were detected above Lava Falls, which suggests that spawning is occurring above that point in the river. This is encouraging for native fish restoration because it indicates that razorback suckers may be naturally reproducing in an area where the species had not been detected in more than 20 years.

In 2018, the FWS completed rigorous species status assessments that recommended downlisting the razorback sucker and the humpback chub from endangered to threatened. Downlisting a species requires formal notification via the Federal Register and a public review process that likely will not begin until 2020 for either fish. Both species are found in multiple population centers throughout the Upper and Lower Colorado River basins.

### **Tribal Activities**

Reclamation continued to fund five American Indian Tribes (Hopi, Hualapai, Pueblo of Zuni, Kaibab Paiute, and the Navajo Nation) to participate in 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. Interactions between the AMP and the American Indian Tribes have been facilitated in recent years by two Joint Tribal Liaisons. However, one of the liaisons resigned near the end of fiscal year 2019. Reclamation will work with Interior to evaluate the success of the liaison program and explore opportunities for improvement prior to filling the vacant position.

In addition to the high-flow experimental release and consultations per the LTEMP ROD, Reclamation continues to conduct government-to-government consultations with American Indian Tribes on operations of Glen Canyon Dam and activities of the AMP in support of its responsibilities, including those under Section 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 Section 106 of the National Historic Preservation Act for the 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, completed a new Programmatic Agreement (May 9, 2017) for the operation of Glen Canyon Dam pursuant to the GCPA that is consistent with the LTEMP. Reclamation also completed a Historic Preservation Plan (November 5, 2018) as required by the LTEMP Programmatic Agreement in fiscal year 2018. In accordance with the 2017 Programmatic Agreement, Reclamation will soon initiate consultation to replace the non-native fish control MOAs.

### **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 2019 are described by the NPS in the following section of this report.

## **National Park Service**

Three units of the NPS (Glen Canyon National Recreation Area [GLCA], Grand Canyon National Park [GRCA], and Lake Mead National Recreation Area) provide support for various AMP operations and activities. In 2019, staff from the Intermountain Regional Office (IMR), along with staff from GLCA and GRCA continued to work with Reclamation and the other AMP agencies on reviewing information for a potential HFE. Based upon agency recommendations, the decision was made by the Secretary to go forward with a fall HFE in 2019 to address the protection of sediment-related resources through the Grand Canyon. Staff from the NPS continued to work with Reclamation on implementation of the LTEMP ROD, including processing interagency agreements and conducting planning to address environmental commitments for cultural resources, endangered species, avifauna, and vegetation management.

### **LTEMP EIS and Record of Decision (ROD)**

Since completion of the LTEMP EIS and ROD 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. NPS worked with Reclamation on interagency agreements for fisheries, archaeological monitoring and mitigation, vegetation monitoring and mitigation, and avifauna monitoring to pursue parts of the triennial work plan and budget that were priorities for 2019. For the LTEMP vegetation project, NPS held several meetings with the GCMRC and tribes to work through the scientific recommendations and the aspects of these projects important to tribes.

### **Expanded Non-Native Aquatic Species Management Plan**

In 2019, NPS finalized the Expanded Non-Native Aquatic Species Management Plan and Environmental Assessment (EA). The NPS solicited input from Tribes, cooperators and AMP stakeholders on the development of alternatives and the final EA. A programmatic agreement and Finding of No Significant Impact (FONSI) were signed in September 2019. The work with partners provided NPS with the opportunity to develop an adaptive, tiered approach to non-native aquatic species management that allows for the use of many tools but addresses concerns by using less

management intensive approaches first. The selected alternative allows for a proactive approach to non-native removal that allows anglers and tribal youth and elders to get involved with removing non-native fish through an incentivized harvest program.

As in 2015-2018, green sunfish were detected downstream of Glen Canyon Dam in the summer of 2019. Similar to prior years, distribution was limited with these fish detected only in one small off-channel pond 3 miles below the dam at river mile –12. Green sunfish have the potential to rapidly invade and expand populations which can lead to preying on and competing with native fish. Given these concerns and the fact that the pond would be inundated by HFE flows, it was determined that green sunfish should again be removed from the area. In October 2017 and 2018, in cooperation with the NPS and AGFD, the backwater was successfully treated with ammonia as an experimental piscicide to remove green sunfish. In September 2019, following the guidance from the selected alternative in the Expanded Nonnative Aquatic Species Management Plan, NPS pumped water out of the pond until only a few small pools remained. These were spot treated with a backpack electroshocker to remove the small number of remaining green sunfish. These actions successfully reduced the green sunfish population by over 95% from this area ahead of the decision deadline for a potential HFE.

### **Archaeological/Cultural Resources**

Grand Canyon National Park: In 2019 an archaeological site monitoring river trip was conducted (May 15 –June 2). The primary objective of the river trip was to conduct assessments at archaeological sites documenting current conditions, impacts, and treatment recommendations. Joint agency participation between NPS and Reclamation allowed agency archaeologists to visit locations where previous treatments have been implemented and where other LTEMP studies are ongoing, and to discuss areas of collaboration related to LTEMP cultural resources. In total, 81 archaeological sites were assessed for disturbances and current condition. A majority of sites (65 sites, 80%) were classified as “good” condition. Of the remaining 16 sites, 14 were in “fair” condition and two were in “poor” condition. There are 39 sites where active disturbances were noted; fifty-four impacts were documented. The remaining sites visited show no evidence of active disturbance though threats, particularly from water erosion remain. Water erosion continues to be the most documented impact to LTEMP archaeological sites. Natural disturbances, in contrast to visitor-caused disturbances, remain more frequently documented.

Glen Canyon National Recreation Area: Staff from GLCA implemented the second year of a new long-term monitoring and protection plan for the cultural resources found in the Glen Canyon Reach. The NPS scheduled and hosted boat trips as requested by tribes in the Glen Canyon Reach, including a couple of trips with representatives from the Southern Paiute Consortium in order to allow them to advise the NPS on the riparian vegetation restoration project and to get input on restoration efforts at the Descending Sheep Panel and other petroglyph sites frequented by park visitors. GLCA staff also continued to support the GCMRC’s monitoring of dam-related topographic changes at select cultural sites including a second round of using a helium filled balloon and photogrammetry camera equipment to collect pictures of specific sites as a possible monitoring tool.

### **Tribal Consultation**

In 2019, 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. GRCA and GLCA

continued discussions with tribes and incorporated tribal perspectives into implementation of the NPS Comprehensive Fisheries Management Plan and the LTEMP. A programmatic agreement was completed for the Expanded Non-Native Aquatic Species Management Plan, which addresses additional concerns about non-native fish and aquatic organisms below the dam and includes a tiered set of tools for addressing these concerns. GLCA and GRCA completed the programmatic agreement after numerous discussions with the Arizona State Historic Preservation Office, Advisory Council on Historic Preservation, and the tribes who had expressed an interest in participating including the Hopi Tribe, Hualapai Tribe, Kaibab and San Juan Paiute Tribes, Navajo Nation, and the Pueblo of Zuni. The insights and concerns of each tribe (primarily from written comments and in-person consultations) provided valuable information to make adjustments and changes to the plan.

### **Humpback Chub Translocation and Fisheries Management**

In 2019, GRCA continued implementation of the Comprehensive Fisheries Management Plan for native fish within GRCA and sport fish in the Lees Ferry area of the GLCA. These efforts included monitoring and collection of endangered humpback chub for future translocations to tributaries and the removal of non-native fishes threatening endangered and native fish in Bright Angel Creek. Monitoring of humpback chub translocated into Bright Angel Creek following successful trout suppression continued in 2019. The recovery of habitat in Shinumo Creek following a fire and flood was also monitored. Monitoring of humpback chub translocation efforts in 2019 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.

Invasive species monitoring continued in 2019 in Glen Canyon with emphasis on invasive fish and quagga mussels. Quagga mussel colonization in the river within Glen Canyon is increasing but remains very sparse. The non-native brown trout population in Glen Canyon continued to increase; brown trout are a high-risk non-native predator that may threaten the rainbow trout fishery in Glen Canyon and humpback chub populations in Grand Canyon. There were numerous public comments from angling groups and guides, AGFD, and tribes expressing concerns about large scale and extensive mechanical harvest efforts to remove brown trout from the Glen Canyon Reach. NPS researched and proposed incentivized harvest strategies resulting in much more favorable support from all of the parties. NPS continued to monitor brown trout using sonic tags, and permitted additional pit tagging of brown trout by GCMRC and AGFD research teams to allow researchers to estimate the population size.

The angler catch rate of rainbow trout within Glen Canyon continued to improve in the lower 2.5 miles of the Colorado River above the mouth of the Paria River which is accessible by walk-in anglers. The AGFD, in coordination with the FWS, continued to stock triploid (sterile) rainbow trout at this location in 2019. The stocking occurred for a two-year time period, which included an experimental design to test the efficacy of the action. The AGFD was the action agency, with funding and ESA compliance provided by the USFWS under their Wildlife and Sport Fish Restoration Program.

## **Wildlife Surveys and Monitoring**

Grand Canyon National Park: In 2019, GRCA conducted monitoring and surveys for ESA-listed Southwestern willow flycatchers and Yuma Ridgway's rail. Presence/absence surveys were conducted for southwestern willow flycatchers (SWFL) using the FWS 3-survey protocol at 14 sites along the Colorado River. Surveys in 2019 were conducted within GRCA between 15 May – 1 June, 8 June – 19 June, and 1 July – 11 July. No SWFLs were detected.

Glen Canyon National Recreation Area: In 2019, GLCA staff and partners conducted great blue heron, waterfowl, and raptor surveys along the 16-mile reach below Glen Canyon Dam. Monitoring of aquatic/riparian invertebrates and terrestrial vertebrate populations utilizing the open water habitat at Leopard Frog Marsh continued. Bat mist netting and sound recording monitoring efforts were completed both above and below the dam to identify the bat species using the Colorado River corridor and as a monitoring effort for white-nose syndrome.

Monitoring for impacts from quagga mussels both above and below the dam and for invasive fish, especially green sunfish, brown trout, walleye, and smallmouth bass, and other invasive species is ongoing. GLCA completed pump-out operations in 2019 to remove most of the green sunfish population that continues to reproduce in the small, off-channel pond located at river mile –12 below the dam. The September operation was specifically conducted to ensure only a few green sunfish would remain in the pond should an HFE be conducted in November of 2019.

## **Vegetation Management/Exotic Species Removal**

Grand Canyon National Park: In 2019, GRCA and partners (including the Ancestral Lands Corps) continued to implement exotic plant species removal at priority sites, expand understanding of plant collection and propagation needs in preparation for future watershed restoration projects, and provide hands-on stewardship opportunities. GRCA also maintained native plants and removed exotic species at Granite Camp and Cardenas Camp as part of the second phase of a pilot riparian restoration project. Specific accomplishments along the river corridor in GRCA were:

- Sixteen campsites were treated for vegetation encroachment and 1.31 hectares (~3.25 acres) of moderate to heavy density arrowweed (*Fallugia paradoxa*) was treated. Vegetation transects were installed at each treatment site and data was collected pre and post treatment. In 2020, treated sites will be revisited to monitor treatment effectiveness and administer additional treatments if needed. The effectiveness of past invasive non-native plant treatments targeting Uruguayan pampas grass (*Cortaderia selloana*) was monitored at seven sites. No evidence of this species was found, indicating that previous treatments had been effective.
- Vegetation removal for cultural site protection was completed at three sites. Vegetation was removed to allow sand deposition and aeolian transport to occur. Data will be collected over the next three years to determine treatment effectiveness.
- Invasive non-native plants (i.e. camelthorn [*Alhagi maurorum*] and perennial pepperweed [*Lepidium latifolium*]) were treated (total plants treated = 5,466) at six sites covering 1.33 hectares (~3.29 acres).

Glen Canyon National Recreation Area: In 2019, the NPS, partners, Tribal youth work groups, 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 GLCA were:



- Continued native seed collection and plant propagation in order to begin riparian plant restoration in important habitat areas in the Glen Canyon Reach.
- Tribal youth and other crews helped to remove a stand of dead tamarisk at river mile 7 in preparation for riparian restoration plantings in 2020 and 2021. This involved removing hundreds of dead adult tamarisk, cutting them into firewood-sized pieces, and then transporting them by boat and raft down to the Lees Ferry boat ramp. Navajo Nation members were notified and came and loaded the firewood for use in wood burning stoves.

## **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. A number of significant events affected research permitting operations in 2019 including the longest-ever 34-day government shutdown; the resignation and retirements of staff at both GRCA and GCMRC; new tribal Principal Investigators for the Hopi Tribe and Navajo Nation.

GCMRC was issued 11 Scientific Research and Collection Permits and 22 Administrative River Launch Permits, totaling 4,717 river user days for the 2019 calendar year. Reclamation was issued one Scientific Research and Collection Permit and seven Administrative Launch Permits, totaling 440 river user days. In comparison, an average sized commercial river company such as OARS, has an allotment of 7,355 user days.

Five of the AMP affiliated American Indian tribes requested renewal research permits with corresponding river trips this year: Hopi, Hualapai, Navajo, Zuni, and Kaibab Paiute tribes. July afforded AMP officials and tribal leaders the opportunity to participate in the Adaptive Management Program Stakeholders and Tribal Leaders Integrated Trip. In 2019, the total number of river user days focused on tribal relationships and monitoring was 1,262. All tribes utilized GCMRC as their outfitter for these river trips. Overall, there was a net increase of 1,321 user days (up from 2018's efforts) for a total of 6,419 user days spent on the river conducting AMP-related research in 2019.

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, several GRCA Science and Resource Management staff members participated in AMP-related meetings and river trips including the GCMRC Annual Reporting meeting, Glen Canyon Dam Technical Work Group meetings, workshops, as well as other meetings with 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 2019. An additional 50 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. GRCA currently has 101 active research permits and anticipates continuation of research and permitting activities in 2020 at similar levels as 2019.

GLCA continued administration of 10 research permits associated with the AMP between Glen Canyon Dam and the Paria River. The NPS anticipates continuation of research and permitting activities in 2020 at similar levels as 2019.

### **Resource Monitoring and Mitigation**

In 2019, GRCA continued 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.

GLCA continued to spread the Clean, Drain, Dry message in partnership 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, quagga mussels, brown trout, and green sunfish) present extreme potential impacts to a wide range of GLCA associated resources. The NPS maintains boot cleaning stations at Lees Ferry which include educational information on the importance of not spreading aquatic invasive species. Cultural resource staff conducted the annual monitoring of cultural sites and eroding banks in order to track and document any new threats to the known archeological sites in the reach.

### **United States Fish and Wildlife Service**

The FWS has participated in the LTEMP as a cooperating agency and has transitioned efforts to supporting implementation of the plan pursuant to the LTEMP ROD. The FWS continues to cooperate with the NPS regarding the Comprehensive Fisheries Management Plan, which guides NPS activities for native and non-native fish in GRCA and GLCA. Additionally, the FWS was a cooperating agency on the NPS Expanded Non-Native Aquatic Species Management Plan and completed Section 7 consultation with the NPS for this plan. 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.

In 2019, 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 2019 were similar to 2018 and continue a reversal of declines observed 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 2019, the FWS continued this translocation effort, but due to low reproduction, only 49 humpback chub were translocated upstream of Chute Falls.

The FWS has continued to lead work in collaboration with the GCMRC and GRCA in the collection and transport of young humpback chub from the Little Colorado River to the Southwest Native Aquatic Research and Recovery Center for future translocation into Havasu, Shinumo, or Bright Angel creeks. Approximately 650 larval humpback chub were collected in 2019 for grow-out and future translocations. The FWS works collaboratively with GRCA to plan for humpback chub translocations into Bright Angel Creek. However, in 2019, no humpback chub were stocked in Bright Angel Creek.

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 2019, the FWS and GCMRC conducted one sampling trip to assess population size of humpback chub in these aggregations. Since 2014, humpback chub populations in western Grand Canyon have increased in size. Large numbers of juvenile and adult humpback chub and detection of sexually mature individuals provide evidence of an expanding population comprised largely of in-situ spawning and recruitment in West Grand Canyon.

The AGFD requested funding and regulatory support from the FWS Wildlife and Sport Fish Restoration Program and the Ecological Services Office to stock triploid (non-reproductive) rainbow trout into walk-in portions of the Lees Ferry rainbow trout fishery. The FWS provided support for this plan, which included grant funding, ESA compliance, and tribal consultation compliance. Approximately 6,000 triploid trout were stocked during spring of 2019. With the assistance and support of multiple partners, monitoring and reporting of the impacts and efficacy of this action are ongoing.

## **United States Geological Survey**

In 2019, the GCMRC continued to serve in its role as the primary science provider to the AMP. The GCMRC's primary activities during 2019 were: (1) collaborating with Reclamation and WAPA to develop the experimental bug flows hydrograph and then monitoring ecosystem response to this flow experiment during its implementation; (2) 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; (3) implementing the second year of a three-year Budget and Work Plan encompassing fiscal years 2018-2020; (4) maintaining a stream flow and sediment transport measurement and internet-based real-time reporting program that was the foundation for planning and implementing HFEs; (5) analysis of these data so as to inform dam and river management activities on the possibility of HFE occurrence; (6) collection and reporting of data describing resource conditions following HFEs; (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; (8) monitoring key cultural resources and geomorphic processes that may affect them; and (9) providing science support for experimental riparian vegetation management. Additionally, the GCMRC conducted numerous field and laboratory studies, published the results of numerous scientific

investigations, provided logistical support for river trips and other field activities, and provided scientific support for implementation of the LTEMP EIS and ROD.

### **Bug Flows Implementation and Monitoring**

In 2019, GCMRC monitored ecosystem response to experimental bug flow releases from Glen Canyon Dam and assisted with the design and implementation of the flow experiment. Aquatic insects are an important prey item that fuels growth of fish, birds, bats, and countless other wildlife living in and along the Colorado River. However, prior studies by GCMRC demonstrated that the low diversity and abundance of aquatic insects in the Colorado River was limiting the growth and condition of native and desired non-native fish populations. A 2016 paper by GCMRC scientists demonstrated that the hourly variation in flows arising from hydropower production was limiting aquatic insect abundance and diversity by causing desiccation and mortality of insect eggs laid along unstable river shorelines. Bug flows (also known as macroinvertebrate production flows) are intended to increase the diversity and abundance of aquatic insects by improving egg laying conditions for these aquatic insects. Monitoring data in 2018 showed that the number of adult aquatic insects emerging from the Colorado River on weekends when flows were steady was > 30% higher than the number of aquatic insects emerging during weekdays with fluctuating flows for hydropower production.

GCMRC collaborated with WAPA and Reclamation staff to design and implement experimental bug flow releases from Glen Canyon Dam in 2019. This included determining the appropriate flow level for weekend steady flows for each month of the experiment and routing these flows through Grand Canyon to predict how aquatic insects would respond at various locations of management interest. In 2019, bug flows occurred from May through August. These experimental releases involved low, steady flows on weekends to enhance egg laying conditions for aquatic insects while minimizing impacts to hydropower production. Fluctuating flows for hydropower production occurred during weekdays and included slightly higher peaks than normal to compensate for the lower weekend flows.

GCMRC monitored ecosystem response to the 2019 bug flow experiment by launching river trips in spring and fall, through continuation of long-term citizen science insect monitoring in Grand Canyon, through continuation of insect drift and emergence monitoring in Glen Canyon, and by using time-lapse cameras to quantify egg laying activity at different flow levels. Time lapse photos taken during the experiment showed that large numbers of aquatic insect eggs were being laid each weekend during bug flows, as predicted, and these eggs were staying wet and were therefore likely to hatch and contribute to insect populations. The average number of caddisflies, an aquatic insect that is sensitive to disturbance, captured in citizen science light traps increased four-fold throughout the Grand Canyon in the first summer of bug flows in 2018 compared to yearly average light trap catches from 2012-2017. This large increase in the abundance of sensitive caddisflies compared to six prior years of baseline data is another indication that bug flows are improving the diversity and abundance of aquatic insects in the Colorado River. A similarly large increase in caddisflies was not observed in 2019. However, this may have been the result of unusually high levels of suspended sediment arising from tributary flooding during the very wet winter of 2019, which has detrimental

effects on larval caddisflies. Despite this potential environmental disadvantage, during the second summer of bug flows in 2019 caddisfly numbers were still the second highest on record.

As of 2019, the effect of bug flows on rainbow trout is inconclusive. Implementation of stable bug flows appears not to have had a positive effect on rainbow trout growth and overall condition, which are affected more by other factors such as fish density, biomass, and nutrient availability.

### **Annual Reporting Meeting**

In March 2019, 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 March meeting were biology, ecology, hydrology, sediment transport, geomorphology, cultural resources, and recreation resources. Presentations concerning the effects of the 2012, 2013, 2014, 2016 and 2018 HFEs were also presented at GCMRC's March 2019 annual reporting meeting. Additional information about the effects of these HFEs was also presented at the AMWG meeting in March 2019.

### **Implementation of Stream Flow and Sediment Measurement Program in Support of the LTEMP ROD**

The periods from December 1 to June 30 and July 1 to November 30, 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 ROD. The HFE 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 ([https://www.gcmrc.gov/discharge\\_qw\\_sediment/index.jsp](https://www.gcmrc.gov/discharge_qw_sediment/index.jsp)). Data from physical samples were shared with Reclamation via the GCMRC website on a bi-weekly basis in order to provide sediment data in a near real-time format for HFE planning purposes.

### **Analyses of Sediment Transport Data to Inform HFE Planning and Design**

The GCMRC measurements indicated that 342,000 - 418,000 metric tons of sand were supplied to the Colorado River by the Paria River between December 1, 2018, and June 30, 2019, and that between 281,000 and 311,000 metric tons of sand were exported from Marble Canyon during this same period. The GCMRC measurements also indicated that between 47,000 and 58,000 metric tons of sand were supplied to the Colorado River by the Paria River between July 1 and November 30, 2019, and that between 327,000 and 361,000 metric tons of sand were exported from Marble Canyon during this same period. Thus, during the spring accumulation period (December 1, 2018, through June 30, 2019) a small amount of accumulation of sand from Marble Canyon occurred, whereas during the fall accumulation period (July 1 through November 30, 2019) substantial net sand erosion from Marble Canyon occurred. Although the amount of newly delivered sand retained in Marble Canyon during the spring 2019 sediment accumulation period was sufficient to trigger a short-duration HFE, spring HFEs were not yet allowed under the LTEMP ROD in 2019. Given that much more sand was eroded from Marble Canyon than was supplied by the Paria River during the fall 2019 sediment accumulation period, an HFE was not recommended in November 2019.

## **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 collected photographic data and recovered gaging station data in February 2019. Preliminary results indicate that there was sandbar building in Marble and Grand Canyons caused by each of the fall HFEs conducted in November 2012, 2013, 2014, 2016, and 2018 (water years 2013, 2014, 2015, 2017, and 2019). Sandbar size at most sites (> 88%) either increased or was maintained in response to each HFE. No HFE occurred in fall 2015, 2017 or 2019 (water years 2016, 2018, and 2020) and preliminary results indicate erosion occurred at most monitored sandbars as a result of normal dam operations (e.g., daily variation in flows due to hydropower load-following) in water years 2016, 2018 and 2019. Nonetheless, the most recent topographic surveys of long-term monitoring sites from fall 2019 (water year 2020) indicate that most sandbars continued to increase in size since implementation of the HFE Protocol in 2012.

During 2019, GCMRC continued to monitor the effects of the HFE Protocol (which began in 2012) on source-bordering aeolian dune fields that contain archaeological sites within GRCA. There are 57 large, source-bordering aeolian dune fields along the Colorado River in Grand Canyon and another 60 similarly large areas of unvegetated sand located at high elevations outside of the active river channel. Many of those dune fields and high elevation sand areas contain archaeological sites. While HFEs do not directly inundate most of these areas, they do resupply them with river sand by rebuilding upwind sandbars.

The LTEMP EIS predicted that conditions for achieving the goal of preservation of cultural resources, termed “preservation in place,” will be enhanced as a result of implementing the selected alternative. HFEs are one component of the selected alternative that will be used to resupply sediment to sandbars in Marble and Grand Canyons, which in conjunction with targeted vegetation removal (described below as Vegetation Management/Exotic Species Removal conducted by NPS in GRCA), is expected to resupply more sediment via wind transport from HFE-deposited sandbars to dune fields and archaeological sites. While HFEs have been shown to directly erode terraces that contain archaeological sites in GLCA, HFEs have also been shown to rebuild or maintain sandbars that provide sand to resupply aeolian dune fields containing archaeological sites throughout Marble and Grand Canyons.

GCMRC infers that the relative success of HFEs as a regulated-river management tool for resupplying sediment to dune fields that contain archaeological sites is analogous to the frequency of resupply observed for river sandbars. GCMRC determined that dune field sediment storage increased cumulatively when HFEs were conducted consistently on an annual basis from 2012 to 2014. However, sediment storage more commonly decreased during one-year hiatuses from HFEs such as occurred in 2015, 2017 and 2019. GCMRC used these research and monitoring results to help design and participate in experimental vegetation removal treatments that were implemented by the NPS in 2019 and will be completed again by NPS in 2020 in Grand Canyon to increase aeolian sediment supply from HFE sandbars to several dune fields that host archaeological sites (see *Vegetation Management/Exotic Species Removal* conducted by NPS in GRCA above and *Science Support for Experimental Riparian Vegetation Management* below for more detail).

Rainbow trout populations and the aquatic food base in Glen Canyon were sampled before and after each of the November 2012, 2013, 2014, 2016, and 2018 HFEs to evaluate any effects on the

aquatic ecosystem. Based on data from 2012-2019, results indicate that fall HFEs do not trigger downstream movement of rainbow trout, but they may have a weak effect on trout growth and condition. Rainbow trout abundance in Glen Canyon declined substantially over the period that included the November 2012, 2013, and 2014 HFEs, and, also through 2015. However, rather than an effect of fall HFEs, the rainbow trout population crash in 2014-2015 appears to be related to an overabundance of young trout produced in water year 2011 following an equalization event combined with a limited aquatic food base stemming from a reduction in soluble reactive phosphorus from the Lake Powell. The abundance of young rainbow trout increased dramatically in 2016 and 2017, with the latter year representing the largest recruitment event since 2011. Rainbow trout abundance of catchable sized fish remained stable from 2017-2019 and trout relative condition has remained above 1.0, suggesting a recovery of the rainbow trout population is underway.

Catches of non-native brown trout have been increasing in Glen Canyon coincident with the implementation of the HFE Protocol. Declines in the condition of multiple fish species, including rainbow trout have been associated with deterioration of the food base though brown trout appear to be thriving. An incentivized harvest program is currently in development by NPS and will be implemented starting in 2020, with the goal of decreasing the population size of predatory brown trout to reduce risk to downstream humpback chub populations. The influence of fall HFEs on this species is unknown but is a topic of ongoing discussion among scientists and managers.

### **Fisheries Information in Support of the LTEMP ROD**

In 2019, GCMRC conducted monitoring of native and non-native fish populations in support of the LTEMP ROD and its associated BO for endangered species. The BO identifies several triggers which, if met, require management actions to be taken to protect humpback chub. The BO includes two tiers of possible actions to protect humpback chub. The first specifies actions to benefit humpback chub directly and the second looks to reduce non-native fish populations. GCMRC provides information related to 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 to support the BO.

In 2019, GCMRC humpback chub research included sampling trips to the lower Little Colorado River, the neighboring reaches of the Colorado River, and in the Colorado River near Fall Canyon. To complement these more spatially intensive sampling efforts, 2019 sampling also included more widespread sampling of the Colorado River via humpback chub aggregations and backwater seining trips. The GCMRC and its cooperators generated estimates of the abundance of several life stages of humpback chub in the Little Colorado River and near its confluence with the Colorado River, as well as survival rates of juvenile humpback chub in this latter area. Overall, adult and sub-adult humpback chub abundance in both the Little Colorado River and near its confluence with the Colorado River were above levels identified in the BO that would trigger action. Therefore, no additional actions to benefit humpback chub or control non-native fish abundance above and beyond those conservation measures currently implemented as part of the LTEMP were required or implemented.

Green sunfish were detected in 2015-2019 in the Colorado River downstream from Glen Canyon Dam. Similar to 2018, distribution of green sunfish in Glen Canyon in 2019 was limited with these fish found primarily in a small pond off the main channel of the Colorado River called the 'slough'. A small number of green sunfish (8) were captured in the main river during sampling efforts by

GCMRC and AGFD in 2019. Green sunfish have rapid invasion and expansion potential and prey upon and compete with native fishes. Given these concerns and the fact that the pond would be inundated by HFE flows, potentially flushing them into the main river, it was determined that green sunfish should be eradicated from the slough prior to any HFE. In October 2017 and 2018, in cooperation with the NPS and AGFD, the backwater was successfully treated with ammonia as an experimental piscicide to remove green sunfish.

### **Cultural Resource Monitoring in Support of the LTEMP ROD and AMP**

In 2019, GCMRC scientists continued to implement the plan for monitoring effects of dam operations, as well as non-flow actions of the LTEMP, on the geomorphic condition of archaeological sites. The monitoring plan was prepared in 2015 in consultation with Reclamation, the NPS, and American Indian Tribes affiliated with the AMP and initially implemented in fiscal year 2016. In May 2019, GCMRC scientists continued to map and monitor archaeological sites in Grand Canyon using terrestrial LIDAR and other methods as described in the monitoring plan. In addition, GCMRC scientists continued to compile repeat photographs of historical images from the river corridor to assess changes in the sand source areas that resupply sediment to archaeological sites and also to assess changes in the distribution, abundance, and diversity of riparian plant species, including many species that are traditionally valued and utilized by American Indian Tribes affiliated with the AMP.

### **Science Support for Experimental Riparian Vegetation Management**

In 2019, GCMRC worked with NPS staff and tribal partners to design and implement experimental vegetation removal at several locations along the river. Project partners included NPS, GCMRC, Hopi Tribe, Hualapai Tribe, Navajo Nation, Southern Paiute Consortium, and Pueblo of Zuni. The purpose of the experimental vegetation removal effort is to create more camping space for recreational visitors and to improve transport of river sand between near shore sandbars and aeolian dune fields and associated archaeological sites that are located farther from the river. As a project partner, GCMRC's roles and responsibilities are to: (1) provide input to NPS and tribal partners on project design, site selection, and methods for implementation and monitoring, (2) provide scientific support via monitoring and research to evaluate vegetation management treatment outcomes, effectiveness, and success, (3) provide objective advice on project efficiency and adaptive management, and (4) help manage project data while respecting tribal data sensitivity.

GCMRC participated in a river trip in April 2019 implemented by NPS and tribal partners to conduct vegetation removal. GCMRC also sent scientists immediately following vegetation removals to acquire baseline monitoring data to evaluate the effectiveness of the removal treatments. GCMRC also helped to develop pilot studies that were implemented by the project partners for vegetation management treatments in GLCA in 2019.

### **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 aquatic 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. In addition, GCMRC was permitted and provided logistics support for 26 mainstem river trips downstream of Lees Ferry in 2019. Trips in 2019 included 15 AMP approved research and monitoring trips led by GCMRC or cooperating agency scientists. Four of these trips launched from Diamond Creek, one by FWS and two by AGFD, to monitor fish populations and one by GCMRC to monitor riparian vegetation. The remainder of the trips launched from Lees Ferry. In addition, four tribal-led monitoring trips and two youth “Partners in Science” trips also launched from Lees Ferry. The GCMRC was also permitted and provided logistics support for 11 trips upstream of Lees Ferry in Glen Canyon to conduct AMP-funded projects. These included seven trips to monitor trout populations (four led by GCMRC and three led by AGFD), and two trips led by GCMRC to monitor riparian vegetation as well as two trips lead by GCMRC to study the aquatic food base during bug flows. Logistics support, including helicopter transport, was also provided for AMP-funded projects in the Little Colorado River conducted by the FWS, AGFD, and GCMRC. Five Little Colorado River trips supported by helicopter operations were conducted in 2019 (same as in 2018) 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 and collaborators held focus groups with tribal members of the Navajo Nation and the Hualapai Tribe on several occasions in 2019 to implement a socioeconomic survey that was developed with tribal involvement. The socioeconomic survey gathered information related to tribal perspectives of, and preferences for, resource management in Glen and Grand Canyons. The implementation of the survey required continued involvement in 2019 with the Navajo Nation Human Research Review Board and tribal representatives to the AMP. In 2019, GCMRC continued to provide appropriate funding for tribal participation in the AMP.

## **2020 Dam Operations (Projected) and Adaptive Management**

### **Bureau of Indian Affairs**

In water year 2020, 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 LTEMP Programmatic Agreement, pre-meetings with tribal representatives prior to AMWG meetings, and 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.

## **Bureau of 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) are part of this collection and set the annual 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 monthly operating hydrographs for different hydrological year classes. These monthly release volumes are found in *Table 1 – Monthly Release Volumes of the Selected Alternative* in the 2016 LTEMP ROD. The LTEMP monthly release volumes will be used in conjunction with Guidelines operations between October 1, 2019, and September 30, 2020 (water year 2020).

The August 2019 24-Month Study projected the January 1, 2020, elevations of Lake Powell and Lake Mead to determine the water year 2020 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, 2020, reservoir elevations of Lake Powell and Lake Mead were projected to be 3,618.56 feet and 1,089.40 feet, respectively. Given these projections, the annual release volume from Lake Powell during water year 2020 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 2020 24-Month Study.

Projected releases from Lake Powell in water year 2020 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. Based on the August 2019 24-Month Study, the projected monthly release volumes for water year 2020 are displayed in Table 2 and the end of water year 2020 elevation for Lake Powell is projected to be 3,640.14.

**Table 2. Projected Lake Powell Monthly Release Volumes for Water Year 2020**

<b>Month</b>	<b>Monthly Release Volumes (in MAF)</b>
October 2019	0.640
November 2019	0.640
December 2019	0.720
January 2020	0.760
February 2020	0.680
March 2020	0.710
April 2020	0.640
May 2020	0.630
June 2020	0.660
July 2020	0.750
August 2020	0.800
September 2020	0.600
<b>Total Releases</b>	<b>8.230</b>

Source: August 2019 24-Month Study

### **LTEMP EIS and ROD**

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 2020, Reclamation will continue a phased implementation of the LTEMP; along with other flow-based experiments, Spring High Flow Experiments will be considered for implementation for the first time under the LTEMP. Ongoing communication and coordination with stakeholders will continue.

### **Conservation Measures for Humpback Chub and Razorback Sucker**

In 2020, ongoing conservation measures will continue as described above for 2019, and consistent with the prescriptions set forth under the LTEMP implementation. Reclamation will work closely with the FWS to determine any implications due to the potential downlisting of both humpback chub and razorback sucker from endangered to threatened. Reclamation will continue to provide funding to the GCMRC for aquatic and sediment research, subject to the availability of funds.

### **Tribal Activities**

In 2020, Reclamation plans to continue to provide funding to the GCMRC and NPS for cultural resources research and monitoring, and will also continue to fund participation and monitoring for the five American Indian Tribes associated with the AMP. Reclamation will continue with National

Historic Preservation Act activities associated with the LTEMP Programmatic Agreement and the Historic Preservation Plan. This plan will ensure continued consultation with interested parties including tribes, identify mitigation measures to address any adverse effects to historic properties, and develop a cultural sensitivity training for all researchers conducting work in the canyons below the dam. Reclamation will work with Interior to evaluate the success of the Joint Tribal Liaison program and to explore opportunities for improvement.

### **Other Activities**

In 2020, Reclamation plans to continue to provide funding to GRCA 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 provide funding to GRCA to conduct management actions that fulfill ESA compliance obligations associated with the LTEMP BO.

## **National Park Service**

### **LTEMP EIS and ROD**

LTEMP implementation of various components will continue in 2020. 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 National Historic Preservation Act Section 106 compliance activities, working with all interested parties on updating plans and developing field review strategies. This work will be guided by the 2018 Historic Preservation Plan.

### **Archaeological/Cultural Resources**

Grand Canyon National Park: In 2020, NPS Archaeological Sites Management Information System condition assessments will be conducted at 50 sites as part of the monitoring for the Grand Canyon Colorado River Management Plan. The NPS is proposing to conduct assessments at 50 high priority locations identified in previous Reclamation treatment documents as recommended for mitigations. The assessments will be conducted jointly with Reclamation as part of the planning process outlined in the Historic Preservation Plan.

Glen Canyon National Recreation Area: Staff from GLCA will finish the third year of monitoring sites using helium filled balloons and photogrammetry camera equipment. The data collected can now be analyzed using software which compares the three years of photogrammetry. Opportunistic cultural resource monitoring will also continue around planned HFEs.

### **Tribal Consultation**

In 2020, 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. GRCA and GLCA will continue discussions with tribes to incorporate tribal perspectives into implementation of the NPS's Comprehensive Fisheries Management Plan, the Expanded Non-Native Aquatic Species Management Plan, as well as the combined Programmatic Agreement for both plans. Tribal

advisors will continue to be consulted on specific monitoring and mitigation protocols.

GRCA 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 to create 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 electrofishing will not be allowed 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 2016-2019 efforts with the Hopi Tribe, Hualapai Tribe, Kaibab Paiute, Navajo Nation, and the Pueblo of Zuni, GLCA anticipates compiling the tribal ethnographic reports for the Glen Canyon Reach into one final report 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.

### **Humpback Chub Translocation and Fisheries Management**

In Grand Canyon, implementation of the Comprehensive Fisheries Management Plan will continue into 2020. These efforts will include monitoring of translocated endangered humpback chub in and around Havasu, Shinumo, and Bright Angel creeks, and the continued removal of non-native fishes threatening endangered and native fish in Bright Angel Creek. Following the first translocation of humpback chub to Bright Angel Creek in 2018, additional monitoring of that population will take place in the spring and fall. A 2020 translocation is planned for 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, NPS, FWS, GCMRC, and others will continue on all fisheries projects.

In Glen Canyon, monitoring for invasive species, especially non-native fish, will continue with partners in 2020. Potential green sunfish reproduction sites, especially in warmer backwater or off-channel areas, will be monitored carefully with partners in 2020 while annual pump out and green sunfish removal actions are continued at the -12 river mile pond.

### **Wildlife Surveys and Monitoring**

Grand Canyon National Park: A study to document bat diversity and seasonal occupancy of bats which was initiated in 2016 will continue in 2020, focusing on captures (acoustic monitoring and mist netting), white-nose syndrome surveillance in new areas of the park, and conducting bat work on a river mission.

Glen Canyon National Recreation Area: In 2020, GLCA plans to continue programs related to aquatic/riparian invertebrates, bats, other terrestrial vertebrate populations, and northern leopard frog habitat enhancements.

## Vegetation Management/Exotic Species Removal

In 2020, NPS staff will continue site maintenance and monitoring at Granite and Cardenas camps. Working with the GCMRC, NPS staff will continue integrating long-term monitoring data into 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 will implement the Colorado River Monitoring Program campsite monitoring and mitigation river mission in spring 2020. Work on this river mission will include campsite monitoring using the Colorado River Management Plan rapid assessment tool, tamarisk beetle monitoring, invasive species removal, and vegetation removal/pruning.

In 2020, the NPS (both GRCA and GLCA), 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.

In 2020, GLCA will begin riparian restoration activities at river mile -12 while continuing the plantings of native plants at river mile -7. NPS staff are working in coordination with GCMRC on monitoring and species selection for replanting. The overall NPS restoration and experimental design plan is being finalized and will be completed early August 2020. This plan will be a cooperative project between IMR, GLCA, GRCA and GCMRC. GLCA will also continue to implement NEPA and NHPA compliance activities included in the LTEMP, as well as other park riparian restoration projects in this reach of the Colorado River. In August 2020, a native youth coordinator will be hired to work with affiliated tribes, and a native youth intern will be hired to support field operations.

Currently, GLCA will plant the following native plants at river mile -7 (Lunch Beach): Utah agave (*Agave utahensis*), coyote gourd (*Curcubita palmata*), hop tree (*Ptelia trifolia*) netleaf hackberry (*Celtis reticulata*), and seep willow (*Baccharis salicina*). During 2020 GLCA plans to propagate the following plants: Goodding's willow (*Salix gooddingii*), Prince's plume (*Stanleya pinnata*), red bud tree (*Cercis orbiculata*), four-wing saltbrush (*Atriplex canescens*), desert olive (*Forestiera pubescens*), galleta grass (*Hilaria jamesii*), mountain pepperplant (*Lepidium montanum*), rubber rabbitbrush (*Ericameria nauseosa*), and sand dropseed (*Sporobolus cryptandrus*).

In 2020, GRCA and partners will conduct non-flow vegetation management actions to mitigate Glen Canyon Dam operation impacts on riparian vegetation along the Colorado River. Vegetation management actions will be implemented at multiple campsites and other areas within the Colorado River corridor. Mitigations include treatment of invasive non-native plant species utilizing chemical and mechanical treatment methods, and control/removal of invasive species encroaching on campsites. In addition, native plant materials such as seed and/or cuttings will be collected at multiple sites in support of future native plant restoration efforts. Target restoration species will likely include: Goodding's willow, Coyote willow, (*Salix exigua*), catclaw acacia (*Senegalia greggii*), velvet ash (*Fraxinus velutina*), singleleaf ash (*Fraxinus anomala*), Fremont cottonwood (*Populus fremontii*), honey mesquite (*Prosopis glandulosa*), netleaf hackberry, Mormon tea (*Ephedra viridis*), beechleaf frangula (*Frangula betulifolia*), Utah agave, California sawgrass (*Cladium californicum*), and bushy bluestem (*Andropogon glomeratus*). GRCA will begin developing comprehensive native plant restoration plans for one or more sites. At multiple sites, GRCA will manage vegetation to assist with cultural site protection. GRCA will monitor the success of vegetation treatments to increase

campable areas, and GCMRC will monitor the success of vegetation treatments for cultural site protection. Tribal youth will assist with implementation of vegetation treatments. GRCA staff will continue site maintenance and monitoring of previous native plant restoration efforts conducted at Granite and Cardenas camps. GRCA staff will implement the Colorado River Monitoring Program campsite monitoring and mitigation river mission in fall 2020. Work on this river mission will include campsite monitoring using the Colorado River Management Plan rapid assessment tool, tamarisk beetle monitoring, invasive species removal, and vegetation removal/pruning.

### **Implementation of the Expanded Non-Native Aquatic Species Management Plan**

NPS plans to initiate research on the efficacy of an incentivized harvest program for removal of brown trout within the Glen Canyon Reach in 2020 once funding has been secured. The Glen Canyon Conservancy will help the NPS and Reclamation administer this program to determine whether public anglers can remove sufficient adult brown trout to control and reduce populations which have incrementally increased since 2014.

### **Research Review and Permitting**

NPS anticipates continuation of research and permitting activities in 2020 at similar levels as 2019. For each of the research projects in support of the GCPA, peer review of the proposals, evaluation of the need for NEPA 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 2020, NPS field work will resume with the resumption of NPS and contracted river operations. One springtime monitoring and campsite mitigation trip is planned. 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 has been completed and is available through various online NPS outlets (<http://www.npshistory.com/publications/grca/nrr-2018-1645.pdf>).

## **United States Fish and Wildlife Service**

In 2020, 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 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 spring of 2020. 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 refining

and implementing a monitoring protocol for effectively sampling the mainstem aggregations of humpback chub and will conduct one sampling trip in 2020. FWS will continue translocation of humpback chub from the lower Little Colorado River upstream to above Chute Falls in 2020.

## **United States Geological Survey**

The major focus of the GCMRC's activities in 2020 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 Triennial 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. In addition, 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 will continue to be provided. 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. GCMRC will continue monitoring and reporting on the condition of resources identified in the LTEMP before and after HFEs as well as in response to bug flows and any other flow and non-flow experiments including vegetation management. The GCMRC will also work with Reclamation in refining experimental planning protocols. In 2020, GCMRC will continue to work with tribal representatives to disseminate preliminary findings to tribal members, tribal governments, and the AMP.