RECLAMATION
Managing Water in the West

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

2015-2016

U.S. Department of the Interior
Bureau of Reclamation

September 2016

EXECUTIVE SUMMARY

This report by the Department of the Interior (Interior) is submitted pursuant to section 1804 of the Grand Canyon Protection Act (GCPA) of 1992, 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.

This report provides an update from the last report, **submitted on August 17, 2015**, by Interior for 2014-2015, and covers dam operations and other activities undertaken pursuant to the GCPA for 2015 and 2016 (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. 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 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.

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

In 1997, the Secretary established the Glen Canyon Dam Adaptive Management Program (GCDAMP) to carry out the requirements of the GCPA. As part of the GCDAMP, 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, currently the Principal Deputy Assistant Secretary for Water and Science, 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 GCDAMP and two Tribal Liaison positions within Interior that assist in coordination between Interior and the tribes. The Western Area Power Administration (Western) 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 GCDAMP, 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 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. 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.

U.S. 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: 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*).

U.S. 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 Grand Canyon National Park and Glen Canyon National Recreation Area. GCMRC provides independent, policy-neutral scientific information to the GCDAMP on (a) 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 (b) the flow and non-flow measures to mitigate adverse effects. The GCMRC's activities are focused on (a) monitoring the status and trends in natural, cultural, and recreational resources that are affected by dam operations, and (b) 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.

2015 OPERATIONS

Bureau of Indian Affairs

In 2015, 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 Liaison to discuss tribal concerns, participated in meetings regarding cultural and natural resources issues and concerns, and participated in the GCDAMP assessment interview. Principal among tribal concerns for 2015 remains the importance of Traditional Cultural Values and their inclusion in the Long-Term Experimental and Management Plan (LTEMP) Environmental Impact Statement (EIS) process and the fact that overall they do not feel they are being consulted with to the level they believe they should be. The BIA commented on draft versions of the LTEMP EIS. The BIA continued to provide its portion of funding to tribes for their participation in the GCDAMP. Other activities included continued coordination of efforts for tribal participation in the GCDAMP, coordinating approval of the green sunfish removal plan, and continuing to work with the Interior Tribal Liaison to maximize tribal consultation and involvement.

Bureau of Reclamation

Water Operations

As in 2010 through 2014, a water year 2015 hydrograph was jointly developed by the Interior AMWG agencies and Western. The recommended hydrograph was consistent with the Law of the River (including the GCPA) and was designed to enhance protection of downstream resources. This approach to operations is consistent with the Interim Guidelines, operating criteria, and 2007 Record of Decision (ROD), and falls within the parameters of the modified

low fluctuating flow (MLFF) alternative adopted in the 1996 ROD. The recommended hydrograph received consensus support from members of the AMWG and was approved by the Secretary on September 30, 2014.

Releases from Lake Powell in water year 2015 continued to reflect consideration of the uses and purposes identified in the authorizing legislation for Glen Canyon Dam and were consistent with the 1996 ROD; the 2012 Environmental Assessment/Finding of No Significant Impact (EA/FONSI) for Development and Implementation of a Protocol for High-Flow Experimental Releases from Glen Canyon Dam, Arizona, 2011-2020; and the 2015 hydrograph. The monthly release volumes for water year 2015 are displayed in Table 1. The end of water year 2015 elevation for Lake Powell was 3,606 feet.

Table 1. Lake Powell Monthly Release Volumes
Water Year 2015

Month	Monthly Release Volumes (maf*)
October 2014	0.598
November 2014	0.777
December 2014	0.864
January 2015	0.862
February 2015	0.589
March 2015	0.649
April 2015	0.600
May 2015	0.699
June 2015	0.800
July 2015	1.048
August 2015	0.799
September 2015	0.714
Total Releases	9.000

*maf = million acre-feet

The third experimental release under the High-Flow Experimental Protocol was successfully conducted during November 2014. Reclamation released the maximum available capacity (38,000 cubic feet per second [cfs]) during the experiment, which began on November 10 and ended on November 15, 2014. Preliminary findings suggest that the first three high-flow experimental 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. Reports from the Grand Canyon white water rafting community have been extremely positive on the improvement of beaches in Grand Canyon over this three-year period. Fisheries researchers have also indicated that these releases have temporarily rebuilt important backwater habitats where sandbars are adequately enhanced throughout Grand Canyon.

In 2015, Reclamation continued to fund and support Grand Canyon National Park with several projects including humpback chub translocations in Havasu and Shinumo creeks, non-native fish removal in Bright Angel Creek, fish surveys in the mainstem Colorado River, a staff position for the permitting office, cultural monitoring, and support staff to complete National Environmental Policy Act (NEPA) compliance for the Glen and Grand Canyon Comprehensive Fisheries Management Plan.

LTEMP EIS

In 2015, Reclamation and the NPS continued developing the LTEMP EIS using the Department of Energy's Argonne National Laboratory as the third-party contractor, funded by Reclamation. The LTEMP EIS team analyzed a range of alternatives and, based on the results of these analyses, developed a preferred alternative that adopted many of the best performing characteristics of the other alternatives. Updates on the LTEMP EIS were provided to the AMWG at each of the three meetings in 2015. The LTEMP EIS team coordinated with the 15 cooperating agencies (including six tribes) on a cooperating agency draft EIS in 2015 prior to releasing the public draft in early 2016. Reclamation and the NPS released a public draft EIS in early 2016 with a goal of issuing a final EIS and ROD in fall 2016.

Conservation Measures for Humpback Chub and Razorback Sucker

From fiscal years 2009 through 2015, Reclamation has funded the NPS to remove non-native rainbow trout and translocate humpback chub into Shinumo Creek, Havasu Creek, and if non-native removal is successful, Bright Angel Creek in order to fulfill: (1) conservation measures from two biological opinions on the operations of Glen Canyon Dam and (2) recovery goals as defined by the FWS for humpback chub that require the establishment of additional reproducing populations of humpback chub. These actions will initially 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.

Approximately 300 tagged humpback chub were introduced per year from 2009 to 2013 in Shinumo Creek. Passive integrated transponder (PIT) tag antennae indicate that high emigration rates occur shortly after a translocation. While some fish leaving Shinumo Creek have relocated into the mainstem aggregations, many have remained in the creek for 3½ years, have growth rates similar to or higher than those seen in the Little Colorado River, and have attained the minimum size and age required for reproduction. No spawning in Shinumo Creek has been detected. Trout have been removed as part of every monitoring trip and the structure of the trout population has shifted from moderate numbers of larger fish to greater numbers of small and young-of-the-year fish. In May 2014, a lightning-caused fire burned 6,100 acres in the drainage and was followed by monsoon flood events in July and August. These events greatly altered habitat conditions for fish and destroyed the PIT tag antennae. Biologists hiked into the drainage in September and observed severe flood disturbance in the translocation reach, below Shinumo falls, and the only fish that could be located were speckled dace. As a result, no translocations occurred in 2014.

As of June 2015, a total of 1,643 PIT-tagged humpback chub had been translocated to Havasu Creek. Prior to the first translocations in 2012, baseline fish surveys were conducted. These surveys turned up a surprising 13 wild humpback chub considered to be resident fish and fortunately, very few non-natives were present in the system. Surveys have relocated many of the tagged fish each year including multiple male humpback chub in spawning condition and ripe females, as well as immature untagged humpback chub, and very small untagged juveniles, all indicating that natural reproduction is occurring in Havasu Creek.

Translocations of humpback chub cannot currently be accomplished in Bright Angel Creek due to the large numbers of brown and rainbow trout that inhabit the creek. Consequently, trout removal efforts were increased beginning in 2012 that include a fish weir to trap spawning brown trout near the confluence and electrofishing trips in Bright Angel Creek from Roaring Springs to the mouth of the creek. Reduction efforts have removed thousands of brown and rainbow trout and as a result, the population structure has changed to very few adult trout. Because of the weir preventing spawning trout from coming in from the mainstem, very little reproduction of trout has occurred. In addition, from November through December 2013, the NPS (in cooperation with the GCMRC) initiated the Bright Angel Creek inflow reduction project as a pilot study within a defined 5.5-mile section of river at the confluence of Bright Angel Creek with the mainstem of the Colorado. Researchers have removed adult brown and rainbow trout preventing them from entering Bright Angel Creek to spawn.

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 translocated to Shinumo Creek and Havasu Creek from 2009-2015 have contributed to the mainstem aggregations that are located at the tributary mouths. Two chub translocated to Shinumo were re-located almost 40 miles upstream at the mouth of the Little Colorado River where they were spawned. Preliminary data analysis from 2014 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. In addition, a large number of adult humpback chub recently located at River Mile (RM) 35 suggests the possibility of a new aggregation or expansion of the 30-mile aggregation. Other areas not associated with known aggregations were sampled in 2013, 2014, and 2015 and results indicate that chub are more widely distributed in the mainstem than had been detected previously.

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 GCDAMP activities. In 2015, Grand Canyon National Park's Research Office issued 22 river trip permits, which fulfilled obligations under the GCDAMP. This was a reduction of four applications from the 26 filed in 2014. Reductions come in part from the inclusion of two collaborative trips with Grand Canyon Youth in existing research permits and the lack of a high-flow experiment (HFE) monitoring trip since no HFE occurred in 2015. The GCMRC was issued seven research and collection permits and 12 river launch permits, totaling 4,137 river user days. In addition to science trips, the GCMRC permits included logistics for five tribal monitoring trips. Due to the sensitivity of the Little Colorado River area to tribes and others, efforts have been made to reduce, combine, and eliminate river trips and helicopter flights into the area wherever possible.

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 has found that the species also uses the Colorado River in western Grand Canyon as far upstream as RM 167.2, just below Havasu Creek. 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.

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. In March 2014, in an attempt to track movements and possibly locate spawning aggregations, nine sonic-tagged adult razorback suckers were released downstream of Lava Falls (RM 180). During the subsequent April monitoring trip, biologists located several of the newly released sonic-tagged fish as well as previously tagged fish that had migrated upstream from Lake Mead. In 2015, there was evidence that razorback sucker 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. Larvae appear to persist for several months in shallow nearshore habitats, although no fully-developed young-of-the-year specimens have been collected to date. The detection of these larvae fish indicates that razorback suckers may be naturally reproducing in an area where the species has not been seen 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 GCDAMP. They identify and monitor traditional cultural properties and provide annual reports detailing their activities, findings, and monitoring 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 GCDAMP on operations of Glen Canyon Dam and activities of the GCDAMP in services 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 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 also continued its efforts with the signatories to develop a new Programmatic Agreement (PA) for operation of Glen Canyon Dam pursuant to the GCPA that is consistent with the LTEMP, and anticipates completing the new PA in conjunction with the LTEMP ROD.

National Park Service

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 2015, staff from the Intermountain Regional Office, along with staff from both Grand Canyon National Park and Glen Canyon National Recreation Area, were instrumental in working with Reclamation and the other agencies on review of a potential November HFE. Due to concerns for the possible downstream dispersal of a population of invasive green sunfish located within the Colorado River of Glen Canyon National Recreation Area, the agencies recommended against implementing an HFE. This recommendation was made after thorough review of the resource information and in consultation with Interior agencies, Arizona Game and Fish Department (AGFD), tribal governments, and stakeholders.

LTEMP EIS

In 2015, the NPS and Reclamation continued developing the LTEMP EIS using the Department of Energy's Argonne National Laboratory as the third-party contractor, funded by Reclamation. The NPS's Intermountain Regional Office, Washington Office, Grand Canyon, Glen Canyon, and Lake Mead all participated in various LTEMP activities including writing, reviewing, and editing sections of draft documents. The NPS also participated in numerous meetings between Interior representatives and tribal and state representatives and continues to work with Reclamation, tribes, the Arizona State Historic Preservation Office, and the Advisory Council on Historic Preservation on compliance related documents.

Archaeological/Cultural Resources

Grand Canyon National Park: Field work in 2015 consisted of condition assessments at 17 river corridor archaeological sites as part of ongoing Colorado River Management Plan implementation. The NPS participated on two tribal monitoring river trips visiting ethnographic resources to determine condition and threats from a tribal perspective. Grand Canyon staff, working with colleagues from the Intermountain Regional Office and Glen Canyon National Recreation Area, continued work on the LTEMP, including review of cultural resources based on geomorphic setting and active processes in conjunction with USGS work. The analysis resulted in a classification for all river corridor sites for future use in planning monitoring and mitigations related to LTEMP activities

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 location.

Glen Canyon National Recreation Area: Staff from Glen Canyon National Recreation Area continued to contribute to the development of the LTEMP EIS. These efforts included clarifying the nature of potential effects from dam operations through field investigations of approximately 30 cultural sites. 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 2015, the NPS continued to participate in consultation meetings with the various tribes who are directly involved in the GCDAMP 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. Tribal advisors were consulted on specific monitoring and mitigation protocols relative to Grand Canyon National Park's Colorado River Management Plan implementation. The NPS participated in on-river monitoring with two tribes and continued to work closely with tribal staff on monitoring and mitigation protocols and implementation.

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.

In the fall of 2015, Grand Canyon National Park and Glen Canyon National Recreation Area engaged in consultations with the Hopi Tribe, Hualapai Tribe, Kaibab Paiute Tribe, Navajo Nation, and the Pueblo of Zuni regarding the 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 engaged in consultation with the Hopi Tribe, Hualapai Tribe, Kaibab Paiute, Navajo Nation, and Pueblo of Zuni to discuss next steps in addressing the mitigation needs of Nine Mile Terrace, a large alluvial terrace more than 15-feet deep with numerous, buried archeological deposits that are at least 3,000 years old. Nine Mile Terrace is adversely affected by fluctuating and high flows related to the operation of the Glen Canyon Dam.

Further, Glen Canyon National Recreation Area discussed with each of those tribes the possibility of ethnographic work to understand the contemporary and cultural significance of archeological sites within the Glen Canyon reach. Funding for that work is being provided by Reclamation as part of their section 106 responsibilities associated with the operation of Glen Canyon Dam, and one of the purposes is to help inform the mitigation of archeological sites that are affected by dam operations within Glen Canyon.

Humpback Chub Translocation and Fisheries Management

In 2015, the Grand Canyon National Park continued implementation of the Comprehensive Fisheries Management Plan for native fish within the 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 newly rediscovered endangered razorback sucker, translocations and/or monitoring of endangered humpback chub to Havasu and Shinumo creeks and the nearby mainstem Colorado River, 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 Shinumo Creek was also monitored.

Invasive species monitoring continued in 2015 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. Brown trout were detected in Glen Canyon at levels about five times higher than previously detected; brown trout are a high-risk non-native predator for targeted mechanical removal in the Comprehensive Fisheries Management Plan.

In July 2015, 43 green sunfish were collected from a backwater in the Colorado River, approximately three miles below Glen Canyon Dam, by the AGFD. This was significantly more than had been collected in this area in previous decades of research and alarmed biologists due to the potential for negative interactions with the population of endangered humpback chub downstream in Grand Canyon National Park. An interagency group of scientists from the AGFD, NPS, USGS, and Reclamation agreed that immediate mechanical removal be attempted. Mechanic removal via boat and backpack electrofishing, seining, and minnow trapping was conducted over two trips; repeated electrofishing passes did not result in depletion of the population.

Based upon these results, it was determined that alternative management options were needed, and a block net was placed across the backwater in the interim. An HFE was cancelled due to the risk of distributing green sunfish downstream. After it was determined that chemical treatments would provide the greatest likelihood of success, a rotenone treatment to eliminate the green sunfish from this backwater and prevent downstream colonization was planned and successfully implemented in November 2015. Green sunfish and incidental mortalities were collected and put to beneficial use after consultation with Traditionally Associated Tribes. This rapid response effort would not have been possible without the collaboration, dedication, and shared vision held by many agencies.

For the river within Glen Canyon, the recreational trout fishery's overall performance is within the accepted range established in the Comprehensive Fisheries Management Plan. Triggers are set for actions, including developing of a plan with the AGFD, to stock sterile rainbow trout. However, creel data for 2015 showed that the trout fishery is underperforming when considering only walk-in accessible fishing locations.

Wildlife Surveys and Monitoring

Grand Canyon National Park: In 2015, Grand Canyon National Park activities included assisting researchers with a desert bighorn sheep study to inform connectivity models, determine genetic diversity of herds, and gain insights on desert bighorn sheep ecology. Park biologists continued monitoring California condors and Mexican spotted owls. In addition, park staff continued collaborative work with the AGFD intended to collect baseline data for bats before the expected arrival of white-nose syndrome.

Glen Canyon National Recreation Area: In 2015, Glen Canyon National Recreation Area staff and partners worked on great blue heron, waterfowl, and raptor surveys along the 16-mile reach below the dam. The great blue heron colony has declined since 2014, with only an estimated ten or fewer active nests. Work continued on monitoring aquatic/riparian invertebrates and terrestrial vertebrate populations creating open water habitat at Leopard Frog Marsh.

Bald Eagle surveys were conducted in January 2015 on the Colorado River and Lake Powell, with 48 individuals documented. This is the second highest count in the region since surveys began in 1990.

The Colorado River was surveyed for waterfowl between Glen Canyon Dam and Lees Ferry on January 5, 2015. Totals included 2,647 individuals of 19 species. A full Lake Powell water bird survey was conducted from January 23-25, 2016. Totals include 5,100 individuals of 27 species. Changes in some species, primarily an increase in common goldeneye, may be related to the spread and increase in quagga mussels in down lake areas.

Vegetation Management/Exotic Species Removal

Grand Canyon National Park: In 2015, 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 plant 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 Adopt-a-Camp program by working with individuals, Grand Canyon Youth, and commercial companies to remove priority exotic plant species from the camps and attraction sites.
- Continued the first riparian restoration project in the river corridor at Granite Camp (RM 94) through site maintenance and outreach to project partners.
- Continued propagation of riparian plant species for supplemental planting at Granite Camp or other future riparian restoration projects.
- Removed the following exotic plant species from along the river corridor and at Lees Ferry:

    - ✓ Ravenna grass – 63 (from along the river corridor)
    - ✓ Russian olive – 29 (from along the river corridor)
    - ✓ Sahara mustard – 461 (from along the river corridor and at Lees Ferry)

- Removed the following exotic plants from the Granite Camp restoration site:

    - ✓ Red brome, London rocket, ripgut brome, and tumble mustard. A total of 3,683 plants were pulled.

Glen Canyon National Recreation Area: In 2015, the NPS, partners, and volunteers implemented 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:

- Grand Canyon Wildlands Council (under cooperative agreement with the NPS) continued monitoring native plant restoration success at Hidden Slough.
- Grand Canyon Wildlands Council and the NPS continued work on re-establishing open water habitat at Leopard Frog Marsh and Hidden Slough.
- Continued native seed collection and plant propagation efforts for restoration activities at Hidden Slough, Leopard Frog Marsh, and Paria River Bridge.
- Conducted initial plantings of native species associated with the Lees Ferry Road and Paria Bridge projects.
- Controlled, mapped, and/or monitored the following invasive non-native species infestations:

    - ✓ Russian olive – No recent plants seen between the dam and Glen Canyon/Grand Canyon boundary.
    - ✓ Tamarisk – Continued monitoring of tamarisk leaf beetle impacts at Hidden Slough, Leopard Frog Marsh, and Lees Ferry.
    - ✓ Ravenna grass – Some remain near the base of the dam in inaccessible areas.
    - ✓ Surveys and some control work on Sahara mustard in Lees Ferry District.

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 150 researchers that are listed as either principal or co-principal investigators presiding over current studies. In 2015, the Grand Canyon's Research Office received 20 river trip applications to fulfill obligations under the GCDAMP. The GCMRC was issued 9 research and collection permits and 13 stand-alone river permits, totaling 4,137 user days. Five tribal research permits with corresponding river trips were permitted for the Hopi, Hualapai, Navajo, Paiute, and Zuni tribes, totaling 889 user days. Overall, 5,026 user days were spent on the river conducting GCDAMP-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 2015, Grand Canyon Science and Resource Management staff participated in GCDAMP-related meetings and river trips; attended and participated in GCMRC's annual

reporting meeting; and attended Glen Canyon Dam Technical Work Group 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 GCDAMP.

Outside of the GCDAMP, the research office continued to review proposals, coordinate efforts, and provide permitting guidance as needed for all GCPA projects in 2015. An additional 55 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 2016 at similar levels as 2015.

The Glen Canyon National Recreation Area continued administration of 11 research permits associated with the GCDAMP between Glen Canyon Dam and the Paria River. The NPS anticipates continuation of research and permitting activities in 2016 at similar levels as 2015. For each of the research projects in support of the GCPA, 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 2015, the Grand Canyon National Park continued the integrated campsite monitoring and mitigation program. The trip conducted in April included rapid campsite monitoring of visitor use impacts (trailing, litter, human waste, etc.) and documenting changes to campsite areas. Changes to campsite areas were documented utilizing high resolution aerial photographs provided by the GCMRC. This method of documenting campsite changes was initiated in 2007, and monitors changes to river corridor campsites including loss or gain of “campable” area due to vegetation growth or slope (loss) or deposition of sand from HFEs (gain). The trip also included rapid vegetation monitoring under the new protocols, which includes documentation of exotic plant species, measurements of barren core, and capture of tamarisk beetle defoliation data.

The Glen Canyon National Recreation Area continued multi-faceted efforts to prevent aquatic invasive species transport to and from Lake Powell and Lees Ferry. Aquatic invasive species present extreme potential impacts to a wide range of GCPA associated resources.

The Glen Canyon National Recreation Area also employed the use of cameras at several localities to monitor terrace erosion and changes related to dam operations and HFEs. This work will continue in 2016.

Greater Grand Canyon Landscape Assessment

In 2014 and 2015 the NPS, in collaboration with Northern Arizona University and numerous other partners (including federal and state agencies, tribes, universities, non-profit organizations, and special interest groups), continued working on the Greater Grand Canyon Landscape

Assessment to assess the condition and trends of natural and cultural resources throughout Grand Canyon National Park and contiguous watersheds. During 2015, the efforts of the previous year's technical work groups, comprised of subject matter experts and interested stakeholders, helped to provide expertise and guidance for assessing the identified focal resources. Data for many of the focal resources has been synthesized and used to develop spatial layers that are being used in subsequent analyses. Staff time was also spent finalizing condition assessments for the focal resources and drafting a NPS Natural Resource Condition Assessment report, which will serve as a baseline for current resource conditions and help guide future park planning and decision making.

U.S. Fish and Wildlife Service

The FWS has been participating in the LTEMP as a cooperating agency and has been active in the development of alternatives and modeling for biological resources through attendance at webinars and providing comments to the joint lead agencies. The FWS led agency cooperators in evaluation and modification of trout removal triggers for inclusion into the LTEMP process. The new triggers are sensitive to tribal concerns with trout removal and provide a more direct conservation benefit to humpback chub.

The FWS continued to consult with 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 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 2015, 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 2015 showed a marked decline in humpback chub in the Little Colorado River and is likely a result of reduced numbers of chub moving into the system from the Colorado River. 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 2015, the FWS continued this translocation effort, moving an additional 303 humpback chub upstream of Chute Falls.

The FWS has continued to work collaboratively with the GCMRC and the Grand Canyon National Park in the collection and transport of young humpback chub for translocation into Havasu Creek. A total of 315 larval humpback chub were collected in 2015, transported to the Southwest Native Aquatic Resources and Recovery Center in Dexter, New Mexico, and will be held there until they are large enough to be marked with a small tag and translocated in 2016.

The FWS, in collaboration with 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 2015, the FWS and the GCMRC conducted one sampling trip to estimate

the population size of humpback chub in these aggregations. Large numbers of young humpback chub were collected in western Grand Canyon and appear to represent downstream population expansion. It is encouraging that the effect of translocating humpback chub into Shinumo and Havasu creeks has resulted in a measurable augmentation of these two mainstem aggregations.

U.S. Geological Survey

In 2015, the GCMRC continued to serve in its role as the primary science provider to the GCDAMP. The GCMRC's primary activities during 2015 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) implementing the first year of a three-year Budget and Work Plan encompassing fiscal years 2015-2017, (3) maintaining a stream flow and sediment transport measurement and internet-based real-time reporting program that was the foundation for planning a November HFE, (4) analysis of those data so as to inform dam and river management activities in the months immediately before the HFE, (5) collection and reporting of data describing resource condition immediately following the November 2014 HFE, (6) collection and reporting of native and non-native fish population data in support of management decisions regarding non-native fish control, and (7) monitoring key cultural resources and physical processes that may affect them. Additionally, the GCMRC conducted numerous field and laboratory studies and provided logistics support for river trips and other field activities as outlined in the fiscal year 2015-2017 Budget and Work Plan, and provided scientific support for development of the LTEMP EIS.

Knowledge Synthesis

In January 2015, the GCMRC conducted a meeting with GCDAMP stakeholders during which results from research and monitoring in key resource areas in Glen and Grand canyons from the previous year were presented. The foci of the January meeting were biology, ecology, hydrology, sediment transport, geomorphology, cultural resources, and recreation resources. Results from research and monitoring conducted by scientists from the GCMRC and cooperating agencies were presented. All materials presented at the workshops were made available in electronic postings at the GCMRC and Reclamation websites.

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

In close cooperation with the GCDAMP stakeholders, the GCMRC implemented the first year of a three-year Budget and Work Plan for fiscal years 2015-2017. Similar to the 2013/2014 Budget and Work Plan, the new 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

The period July 1 to November 30, 2015, marked the fourth "sediment accumulation period" as defined under the High-Flow Experimental Protocol that was adopted by the Secretary in 2012.

This 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 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 real-time format for HFE planning purposes.

The GCMRC staff estimated that between 1,000,000 and 1,300,000 metric tons of sand was delivered from the Paria River to the Colorado River during the period between July 1 and November 30, 2015. Because of the presence of non-native green sunfish, no HFE was conducted in 2015 even though July-November 2015 provided adequate sediment input for an HFE.

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 the design of the HFE hydrograph so as to provide the most effective benefit-to-resource condition and scientific learning, consistent with the protocol defined in the 2012 published environmental assessment. Because the green sunfish issues were not resolved before the end of November, no HFE was conducted in 2015.

Implementation of a Plan to Evaluate HFE Effects

The GCMRC utilizes a network of field time-lapse cameras to evaluate the effects of HFEs on sandbars throughout the Colorado River ecosystem. Scientists were sent into the field in January 2015 to collect photographic data and recover gaging station data. Preliminary results indicate that there was favorable bar building in Marble and Grand canyons caused by each of the fall HFEs conducted from 2012-2014. Sandbar size at a majority of sites (> 88%) either increased or was maintained in response to each HFE. The most recent topographic surveys of long-term monitoring sites from fall 2015 indicate sandbars increased in size during the first four years of implementation of the HFE Protocol.

Presentations concerning the effects of the 2012-2014 HFEs were given at the January 2015 annual reporting meeting described above. Additional information about the effects of these HFEs were presented at a GCDAMP meeting and HFE workshop in late February 2015 and to the Upper Colorado River Commission at its Las Vegas meeting in mid-December 2015. In addition, rainbow trout populations and the aquatic food base in Glen Canyon were sampled before and after each HFE to evaluate any effects on the aquatic ecosystem of the event. Results and analysis to date indicate that HFEs do not trigger downstream movement of rainbow trout and suggest that the aquatic food base only responds weakly to fall HFEs as shown by slight increases in abundance of some aquatic insects and an invasive snail species and slight decreases in abundance of other non-insect invertebrates (tubificid worms and amphipods) within weeks to months of these events.

Fisheries Information in Support of Non-Native Fish Control EA

The GCMRC conducted monitoring of native and non-native fish populations in support of Reclamation's non-native fish control EA and its associated biological opinion for endangered humpback chub. This biological opinion identifies several triggers which if met require management actions to be taken to reduce non-native fish populations in an effort to protect humpback chub. Information provided by the GCMRC for specific triggers includes 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 also generated estimates of the abundance of several life stages of humpback chub in the Little Colorado River itself and near its confluence in the Colorado River, as well as survival rates of juvenile humpback chub in this latter area. None of the trigger levels for humpback chub or trout were reached in 2015 so no non-native fish control actions were required or implemented.

Large numbers of green sunfish were detected in a small backwater in Glen Canyon below Glen Canyon Dam in July of 2015. Green sunfish have rapid invasion and expansion potential and prey upon and compete with native fishes. No HFE was conducted in 2015 because of the risk that it would promote dispersal of this invasive species downstream. Two mechanical removal efforts were unsuccessful in demonstrating a reduction in green sunfish from the area. In November 2015, in cooperation with the NPS and AGFD, the backwater was successfully treated with the chemical rotenone to remove green sunfish.

Cultural Resource Monitoring in Support of the High-Flow Experimental Protocol and GCDAMP

A plan for monitoring geomorphic change at archaeological sites was prepared in consultation with Reclamation, the NPS, and tribes affiliated with the GCDAMP in preparation for implementation in fiscal year 2016. The GCRMC also conducted a geographic information system analysis to investigate how landscape characteristics of terrain located between minimum river flow elevations and maximums that occur during HFEs influence the distribution and area of aeolian sand above the maximum flow elevation. In addition, GCMRC assessed changes in the distribution and abundance of riparian plant species that were traditionally valued and utilized by Tribes affiliated with the GCDAMP.

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 GCDAMP 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 2015, four fewer trips than in 2014. Trips in 2015 included 15 GCDAMP 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; one channel mapping trip which included daily launches from Diamond Creek; and five tribal-led monitoring trips. Logistics support, including helicopter support, was also provided for GCDAMP-funded projects in the Little Colorado River conducted by the FWS, AGFD, and GCRMC. Five Little Colorado River trips were conducted in 2015 (same as in 2014) with each trip requiring two flight days, one to take crews into field camps along the river and one to retrieve them.

Many GCMRC scientists also provided support to the ongoing LTEMP EIS process. Support included model development, data analysis, participation on subject matter expert panels, document review, peer review coordination, development of a draft science plan, and other activities to help ensure a sound scientific foundation for the development of the EIS.

2016 OPERATIONS

Bureau of Indian Affairs

In 2016, the BIA will continue to take an active role in supporting stakeholder tribes related to the GCDAMP. The BIA will participate in meetings concerning the Tribal Consultation Plan, the PA, 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 is also a cooperating agency on the LTEMP EIS and will remain actively involved in that process. The BIA will continue to be involved with any future HFE 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 GCDAMP.

Bureau of Reclamation

Water Operations

As in 2010 through 2015, a water year 2016 hydrograph was jointly developed by the Interior AMWG agencies and Western. The recommended hydrograph is consistent with the Law of the River (including the GCPA) and is designed to enhance the protection of downstream resources. This approach to operations is consistent with the Interim Guidelines, operating criteria, and 2007 ROD, and falls within the parameters of the MLFF alternative adopted in the 1996 ROD. The recommended hydrograph received broad support from members of the AMWG and was approved by the Secretary on November 12, 2015.

Releases from Lake Powell in water year 2016 reflect consideration of the uses and purposes identified in the authorizing legislation for Glen Canyon Dam and were consistent with the 1996 ROD; the 2012 EA/FONSI for Development and Implementation of a Protocol for High-Flow Experimental Releases from Glen Canyon Dam, Arizona, 2011-2020; and the 2016 hydrograph. As of September 28, 2016, the observed and projected monthly release volumes for water year 2016

are displayed in Table 2. The end of water year 2016 elevation for Lake Powell is projected to be 3,611 feet.

Table 2. Lake Powell Monthly Release Volumes
Water Year 2016

Month	Monthly Release Volumes (maf*)
October 2015	0.600
November 2015	0.577
December 2015	0.857
January 2016	0.857
February 2016	0.700
March 2016	0.694
April 2016	0.665
May 2016	0.700
June 2016	0.800
July 2016	0.950
August 2016	0.900
September 2016**	0.700
Total Releases**	9.000

*maf = million acre-feet

** = projected release

Reclamation will continue planning for high-flow experimental releases from Glen Canyon Dam in November 2016 in accordance with the High-Flow Experimental Protocol and Reclamation's May 12, 2012, FONSI.

LTEMP EIS

In 2016, Reclamation and the NPS will continue development of the LTEMP EIS including publication of a public draft document in January 2016. The LTEMP EIS team will conduct follow up meetings with the cooperators and stakeholders during the public comment period and will hold four public meetings to facilitate public participation. The team anticipates publishing a final EIS and ROD in fall 2016.

Conservation Measures for Humpback Chub and Tribal Activities

Many of the activities described above will continue in 2016, but may be modified depending on the completion of the LTEMP EIS and the biological opinion that will follow. Reclamation will continue to provide funding to the GCMRC and the NPS for cultural, aquatic, and sediment research and for the participation of five American Indian Tribes in the GCDAMP (as described above for 2015). Reclamation will continue efforts to develop a new Programmatic Agreement for the operation of Glen Canyon Dam consistent with the action identified in the LTEMP EIS.

National Park Service

LTEMP EIS

The draft will be released in January 2016 and the NPS and Reclamation plan to conduct public meetings in Phoenix and Flagstaff as well as via webinar. The co-lead agencies are anticipating a Record of Decision by fall 2016 and anticipate completing the requisite National Historic Preservation Act compliance agreements in 2016.

Archaeological/Cultural Resources

Grand Canyon National Park: In 2016, work will include participating in tribal monitoring field sessions along the river. One assessment river trip with GCMRC and USGS scientists will document drainage classifications. High resolution mapping using LiDAR at seven locations is intended to track small scale changes associated with dam operations. Participation in at least one tribal river trip is anticipated.

The NPS and tribal consultants continue working collaboratively on an interpretive brochure for the Unkar Delta sites. One river trip will include the NPS and tribes to review the work to date on site.

Glen Canyon National Recreation Area: In 2016, work will include progress in the development and evaluation of monitoring protocols for terrestrial resources to evaluate potential effects resulting from dam operations. Glen Canyon will continue to support the GCMRC's monitoring of dam related topographic changes at select cultural sites and classification of all sites for aeolian transport, drainage type, and erosion ranking. Staff will continue opportunistic monitoring around planned HFEs.

Tribal Consultation

In 2016, the NPS anticipates continued participation in consultation meetings with the various tribes who are directly involved in the GCDAMP 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. 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 2015 consultations with the Hopi Tribe, Hualapai Tribe, Kaibab Paiute, Navajo Nation, and the Pueblo of Zuni, Glen Canyon National Recreation Area anticipates letting sole source contracts with each of those tribes to produce ethnographies that will facilitate contextualization of the archeological 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, will conduct a debriefing with the same tribes to inform them of the outcome of the effort to control the green sunfish invasion and to seek their input on next short-term and long-term plans to minimize further invasions.

Humpback Chub Translocation and Fisheries Management

In Grand Canyon, implementation of the Comprehensive Fisheries Management Plan will continue into 2016. These efforts will include the continuation of the evaluation of the status and habitat use of endangered razorback sucker (year 3), monitoring of translocated endangered humpback chub in and around Havasu and Shinumo creeks, translocation of additional 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 (year 4). The recovery of Shinumo Creek will continue to be monitored for the suitability of humpback chub translocation in the future. Collaboration with Reclamation, 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 2016. Solutions for the brown trout increase will be pursued, including conducting outreach to anglers, development of study designs with researchers, and coordination with commercial fishing guides. Quagga mussel colonization monitoring will continue.

Green sunfish populations, especially in the backwater area, will be monitored carefully with partners in 2016 while long-term solutions are sought and investigated. Potential ways to prevent sunfish reproduction in the backwater include eliminating the backwater (by in filling) and creating water flow-through at certain river levels (to keep the backwater below sunfish reproductive temperatures). These solutions are sought as an alternative to regular chemical treatments, which only treat the symptom and are offensive to tribes and others.

Wildlife Surveys and Monitoring

Grand Canyon National Park: In 2016, the Grand Canyon National Park will continue work on bighorn sheep including distribution and potential disease pathogen identification. Biologists will continue to monitor California condors and Mexican spotted owls and expand work with the AGFD collecting baseline data on bats.

Glen Canyon National Recreation Area: In 2016, Glen Canyon National Recreation Area plans to continue programs related to aquatic/riparian invertebrates and terrestrial vertebrate populations, and northern leopard frog and ambersnail habitat enhancements.

Vegetation Management/Exotic Species Removal

In fiscal year 2016, the NPS will attempt to continue the Adopt-a-Camp program through work with commercial guides. Nursery staff will continue to propagate riparian plant species for future restoration projects along the river corridor. An integrated resource team will select the two sites for the three-year riparian restoration project and will begin project planning to include seed and plant material collection and required surveys and site documentation

In 2016, 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.

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 2016 at similar levels as 2015. For each of the research projects in support of the GCPA, peer review of the proposals, evaluation of 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

The Grand Canyon National Park will continue integrated campsite monitoring in 2016 based on the revised campsite monitoring protocols. The NPS will continue to conduct campsite use surveys. One trip for Lower Gorge campsites is planned to mitigate vegetation encroachment on campsites below Separation Canyon.

Greater Grand Canyon Landscape Assessment

Grand Canyon National Park staff expect to have the Greater Grand Canyon Landscape Assessment completed in May 2016. An interdisciplinary team of NPS experts, agency partners, scientists, and other groups and individuals will complete the assessment and identification of resource conditions and trends and prioritization of conservation needs facilitating ecosystem-based stewardship will come to fruition. The NPS will continue to work on the riparian rehabilitation project at Granite Camp, including the removal of non-native tamarisk and revegetation with native plants.

U.S. Fish and Wildlife Service

In 2016, 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 completing additional translocations of humpback chub in the summer of 2016. 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 2016.

U.S. Geological Survey

The major focus of the GCMRC's activities in 2016 is to continue to serve in its role as the primary science provider to the GCDAMP by conducting the field and laboratory studies described in the fiscal years 2015-2017 Budget and Work Plan. Additionally, the GCMRC plans to continue providing real-time scientific data needed to implement the High-Flow Experimental Protocol. Specifically, the GCMRC will maintain its internet-based real-time reporting of stream flow 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. The GCMRC will continue monitoring and reporting on resource conditions following HFEs and working with Reclamation in refining HFE planning protocols. Native and non-native fish population data will continue to be collected and reported on in support of management decisions regarding non-native fish control. The GCMRC will also provide science support in revising and finalizing the LTEMP EIS and its associated science plan.