

## **Glen Canyon Dam Adaptive Management Program**

**AGENCY:** Bureau of Reclamation, U.S. Fish and Wildlife Service, National Park Service, Bureau of Indian Affairs, U.S. Geological Survey, and Western Area Power Administration

**INVOLVED PARTIES:** Colorado River Basin States (Wyoming, Colorado, Utah, New Mexico, Arizona, Nevada, and California), Arizona Game and Fish Department, Hualapai Tribe, Navajo Nation, Pueblo of Zuni, Hopi Tribe, Southern Paiute Consortium, San Juan Southern Paiute Tribe, Colorado River Energy Distributors Association, Utah Associated Municipal Power, Grand Canyon Trust, Grand Canyon Wildlands Council, Grand Canyon River Guides, and Federation of Flyfishers

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**DATES:** *Began:* 1997 *Ended:* Ongoing

**INTERNET SITE:** <http://www.usbr.gov/uc/rm/amp/>

### **PROJECT DESCRIPTION:**

For decades, there has been significant concern with the ecological impacts of the operation of Glen Canyon Dam on downstream resources, particularly the riparian areas along the Colorado River in the Grand Canyon. In addition to concerns for the impact of Glen Canyon operations on these resources, many questions existed regarding the effects of nonnative fish, recreational usage, and other factors.

Section 1802 of the Grand Canyon Protection Act (Act) of 1992 (Public Law 102-575 directed the Secretary of the Interior to establish and implement long-term monitoring programs and activities to ensure the Glen Canyon Dam is operated "... in such a manner as to pro[t]ect, 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." Implementation of this provision of the Act was required to be made "in a manner fully consistent" with existing law.

In compliance with the Act, the *Operation of Glen Canyon Dam Final Environmental Impact Statement* (EIS) proposed a process of adaptive management (AM) whereby the effects of dam operations and other management actions on downstream resources would be monitored and assessed. The Act and the EIS are the guiding documents for development of the Glen Canyon Dam Adaptive Management Program (GCDAMP).

After years of studies, in a 1996 record of decision (ROD), the GCDAMP was established to provide a mechanism for implementing environmental commitments in the 1995 EIS on operations of Glen Canyon Dam.

Findings from the EIS indicated that many uncertainties still existed regarding the downstream impact of water releases from Glen Canyon Dam and other factors affecting downstream resources. The EIS team consolidated the issues of public concern, identifying the significant resources and associated issues to be analyzed in detail. These resources include water, sediment, fish, vegetation, wildlife and habitat, endangered and other special status species, cultural resources, air quality, recreation, hydropower, and non-use value.

The GCDAMP meets the purpose and strengthens the intent for which the EIS was prepared and ensures the primary mandate of the Act is met by integrating advances in understanding the relevant impacts on downstream resources through experimental actions and robust monitoring to determine whether targeted modifications to dam operations and resource management are advisable.

In order to comply with the consultation requirement of the Act (Section 1805 of the Act), the EIS recommended forming a Federal Advisory Committee. In January 1997, Interior Secretary Babbitt signed a Notice of Establishment of the Glen Canyon Adaptive Management Work Group (AMWG) as that committee. The committee charter was signed on January 15, 1997, and has been renewed multiple times.

Participation of the broad group of stakeholders in the AMWG is a key for an effective, credible AM effort. AMWG is supported by a Technical Work Group (TWG), which provides guidance on technical issues and objectives produced in cooperation with the U.S. Geological Survey (USGS) research center, the Grand Canyon Monitoring and Research Center (GCMRC), regarding the research and monitoring needed to evaluate operations. In addition to the work of the USGS, independent science review panels conduct external peer review of the research and monitoring efforts to ensure that the most appropriate and credible scientific investigations are undertaken.

The AMWG maintains public outreach and involvement in the decision-making process and incorporates those stakeholders with interests in the operation of Glen Canyon Dam and protection of downstream resources. By making sure the best available science is used when considering adjustments and decisions regarding various dam and resource management practices, the AMWG makes recommendations to the Secretary of the Interior on how best to protect resources and meet the requirements of the Grand Canyon Protection Act.

#### **ADAPTIVE MANAGEMENT (AM) ELEMENTS:**

*What management issue was the primary driver?*

Since the late 1980s, it has been clear that the operation of Glen Canyon Dam and its effects on resources in Glen Canyon National Recreation Area and Grand Canyon National Park were the primary drivers leading to the establishment of this AM program.

*What uncertainties led to an Adaptive Management approach being selected?*

Fundamental questions regarding the rates and volumes of water releases from Glen Canyon Dam, the effects of nonnative fish on native fish populations, the role of temperature on effects to native and nonnative species, and the role of fine and coarse sediment retention in the Grand Canyon for recreation and habitat benefits have been among the primary uncertainties regarding the riparian habitat in the Grand Canyon. Broadly speaking, the effects of dam operations on fine sediment conservation, the tailwater trout sportfishery, endangered species impacts, and cultural resources were not fully understood and the subject of disagreement concerning the proposed criteria for operation of Glen Canyon Dam.

*How was the monitoring and science framework designed to support timely management adjustments to changing resource conditions and increased certainty?*

Over the past decade, an extraordinary amount of effort has been invested to design scientific experiments and monitoring programs that are directly linked to ongoing and potential future

management adjustments to dam operations and other management actions to benefit the endangered species, riparian habitat, and other resources of concern. Since the first controlled high flow in 1996, various experiments have been designed, recommended, approved, and monitored involving seasonal low-flow conditions, high-flow flood releases, other variations in release rates, as well as physical removal of nonnative fish.

All of these various experiments have been considered and implemented through the designed structure of the GCDAMP. The AM program has a relatively simple structure with a science institution, the USGS' GCMRC, and science advisors providing input to a TWG of stakeholder representatives who make recommendations to the Federal Advisory Committee, the AMWG. After due consideration, the AMWG, as appropriate, makes recommendations to the Secretary of the Interior on dam operations and other actions under the Secretary's authority. AMWG interactions with the U.S. Department of the Interior (DOI) are facilitated by a Secretary's designee, who also serves as chair of the Federal Advisory Committee.

*Please describe the process used for involving partners/stakeholders.*

Given that the AMWG is a formally chartered Federal Advisory Committee, the AMWG stakeholders have a formal process through regularly scheduled meetings for involvement in the AM processes, including both the TWG and the AMWG. Notice for AMWG meetings is provided through the Bureau of Reclamation's Web site and through *Federal Register* notices. The TWG meets approximately six times a year to consider scientific findings provided by the GCMRC and cooperating scientists. Based on this information, the TWG and GCMRC develop planning documents, budgets, and work plans. AMWG receives this information at meetings occurring two or three times a year. AMWG recommendations are conveyed to the Secretary of the Interior through the Secretary's designee. The program also has developed a public outreach program that allows stakeholders an avenue for communicating their roles and responsibilities, along with program results, to their constituents and the public.

*Please describe the mechanism for adapting decisions based on monitoring results. Was an Environmental Management System (EMS) used?*

Throughout the past decade, there has been a continuous effort to evaluate and adapt management actions for resource protection through experiments (often referred to as "treatments"), which are then monitored for their effects in the Grand Canyon. For example, mobilization of sediment for improved habitat conditions through high-flow releases from Glen Canyon Dam was first undertaken in a 2-week high-flow experimental release in 1996. In 2001, the AMWG asked GCMRC to provide recommendations—based on monitoring completed as of that date—to conduct additional experimental releases to achieve replenishment of beach habitats in the Grand Canyon. Based on years of extensive monitoring, and pursuant to the GCMRC plan, the AMWG recommended a high-flow test of shorter duration that would be specifically timed to take advantage of sediment inflow to the Grand Canyon from winter storms. After thorough review by DOI, including appropriate National Environmental Policy Act (NEPA) compliance, this modified experimental approach was approved in late 2002 and tested in November 2004. As this summary paper is being prepared in the summer of 2006, USGS scientists and other AMWG members are actively reviewing the results of the 2004 experimental release in order to provide further specific recommendations to the Secretary of the Interior for future management of Glen Canyon Dam.

Other examples addressing nonnative fish removal, dam release volumes, and release rates have utilized this same approach, whereby the AMWG considers the results of extensive monitoring and

then makes specific recommendations to the Secretary for adjusting resource management decisions.

No formal environmental management system (EMS) is used in the GCDAMP. The structure of the program is designed to ensure that scientific findings from the AM effort are used as the basis for recommendations to the Federal Advisory Committee. Scientific findings arise from an independent science evaluation by the USGS, which is not a member of the Federal Advisory Committee. The contracts and agreements used to engage scientists for research and monitoring are competitively placed, and responses to requests for proposals are judged by independent peer reviewers. External peer review also is employed to evaluate research and monitoring products to ensure their quality and integrity. Results of scientific investigations are periodically compiled in reports, such as *The State of the Colorado River Ecosystem in Grand Canyon* (Gloss et al. 2005).

*Was the AM approach established as a result of a National Environmental Policy Act (NEPA) process (analysis and documentation supporting the decision to implement the AM)? If so, how did the NEPA process address subsequent adaptive decisions and actions?*

No, the AM program arose through a DOI commitment contained in the 1995 Glen Canyon Dam Operations EIS. The EIS did not provide a comparative analysis and documentation of a future with and without AM. Rather, the EIS and ROD for the implementation of the preferred alternative in the Glen Canyon Dam Operations EIS and the Bureau of Reclamation's response to the associated biological opinion contained a commitment to use AM as a tool in making future policy decisions and for completing the elements of the biological opinion. The ROD identified that the AMWG, as a Federal Advisory Committee, would make recommendations to the Secretary of the Interior as part of the AM process.

*Has the AM approach been evaluated in a subsequent NEPA process? If so, what has AM contributed to the NEPA process?*

Yes, the process has been one of "learning by doing" as practitioners of AM during the course of developing subsequent NEPA documents. The EIS committed to undertaking separate NEPA assessments using the AM process for future agency actions not covered by the EIS analysis. As subsequent experiments have been considered, they have been reviewed to identify whether the individual action was previously assessed in the EIS. To the extent that such subsequent AM actions have not been previously analyzed, they have been subjected to individual environmental compliance.

Scientific findings from AM research and monitoring have been used extensively in NEPA assessments and in adjusting and modifying dam and resource management actions. The AM process has been enormously helpful in carefully evaluating what further management actions would be considered, thereby improving the content, focus, and scope of the subsequent NEPA assessments. Four NEPA assessments have been completed during the course of the AM program. A prime example of the contribution of the AM process to NEPA compliance used by the AMWG is the September 2002 environmental assessment (EA) titled *Proposed Experimental Releases from Glen Canyon Dam and Removal of Nonnative Fish*.

*If the AM approach has not been evaluated through NEPA, are there plans for doing so? If so, briefly describe those plans and how other environmental requirements (e.g., Endangered Species Act, National Historic Preservation Act, wetlands, floodplains, environmental justice) have been complied with?*

The EIS and ROD committed to engage NEPA in the iterative AM process whenever experiments are proposed that have not undergone previous environmental compliance. Policy decisions made by the Secretary of the Interior that would lead to long-term changes in dam operations that go beyond the level of experiments would likely also require additional environmental compliance. In the GCDAMP, AM is looked upon as a tool to facilitate better environmental compliance, rather than environmental compliance being used as a tool to evaluate AM.

## **RESULTS:**

*Benefits provided by AM to date (i.e., reduced uncertainty, improved project efficiency and efficacy compared with other management options):*

There are three important areas in which progress by the GCDAMP AM effort can be evaluated: reduction of uncertainty, increase in stakeholder cooperation, and improvement in resource conditions. GCDAMP science efforts have demonstrated that some paradigms used in predicting effects of the preferred alternative adopted in 1995 were incorrect. For example, the ability to conserve fine sediments in the Colorado River under that flow regime was overestimated. Program members now have a much better understanding of the relationships between hydrology and fine sediment storage and transport than at the time the GCDAMP began. Thus, there has been considerable success in reducing uncertainty surrounding relationships between dam operations and responses of Colorado River resources.

The degree of stakeholder buy-in and cooperation also has shown considerable improvement since inception of the program. Program members hold differing values and perspectives, but they have been able to overcome these differences and achieved success in working together to develop large-scale, ecosystem-level experiments. These experiments would not have been conducted if stakeholders had not achieved consensus and if the DOI had not been convinced that they were in the best interests of achieving program objectives and compliance with existing laws. Clearly, there has been successful collaboration between diverse stakeholders and the DOI in their united effort to conduct the science necessary to understand better the Colorado River ecosystem below the dam.

*Limitations of using AM:*

Improvement of resource conditions has been the most challenging aspect of AM. Fine sediment conservation has improved considerably by utilizing knowledge gained through the program to trigger high experimental flows following sediment inputs from key tributaries. Nonetheless, the large increase in fine sediment stored in Lake Powell combined with natural erosion of beaches has made attainment of a positive sediment budget difficult. It remains to be seen whether sediment augmentation is necessary to maintain beaches and native fish habitats below the dam. A second challenging resource is the endangered humpback chub. During the course of the GCDAMP, both recruitment of this fish and population levels of adults have declined. Recent coupling of mechanical removal of nonnative fish with dam operations designed to disadvantage these fish seems to be showing promise, as native fish levels have recently stabilized, but it is too early to judge whether we have turned the corner on improving the status of the endangered chub.

*Financial cost of implementing AM:*

The GCDAMP has an annual budget of approximately \$8.5 million, which is paid for primarily out of hydropower revenues generated by Glen Canyon Dam.

AM under the GCDAMP has not been a panacea for resolving all conflicts among alternate uses of resources, but it has greatly improved the rate at which knowledge is gained and applied in resolving resource issues. AM results in smaller, incremental changes built upon improved knowledge gained through research and monitoring the ecosystem. Stakeholders have input throughout the process, which improves their trust when decisions are made. The net effect may not be to speed the process so much as to assure that there is greater agreement on the outcome. Although the GCDAMP expends approximately \$8.5 million each year, the investment of these dollars has reaped large rewards in better management and less litigation. Stakeholders who in the past might have resolved their differences in the legal system, at very large cost, now are working together to achieve a set of common objectives. They also have agreed to be patient and risk-tolerant. AM does not promise to eliminate uncertainty completely, but it provides valuable mechanisms for better managing resources in the face of that uncertainty.

*Degree of stakeholder buy-in:*

The 25 stakeholders in the GCDAMP are very engaged in the program. Attendance at and engagement in meetings has been and continues to be very good. Stakeholders have achieved a degree of respect for the positions of one another and they share a commitment to using science to achieve a better understanding of the relationship between dam operations and Colorado River resources.

**CHALLENGES:**

*What impediments, constraints, and/or challenges were overcome? How?*

The greatest challenge faced by the GCDAMP has been the inherent differences in perspective among stakeholders with highly different value systems and resource commitments. These stakeholders have successfully implemented a program that uses science as a foundation for recommendations on resource management. To achieve this goal, stakeholders had to maintain a commitment to an objective, technical basis for understanding the ecosystem and to be tolerant and patient in working with peers having very different politics and perspectives. Although their tolerance and patience waxes and wanes with the issues at hand, they have shown that they can successfully work through these challenges.

*What aspects of the project need improvement?*

There is a recognized need to better define the roles and responsibilities of program members, particularly within subgroups and between scientists and managers. Maintaining a healthy distance between the technical and political elements of the program without sacrificing communication is a challenge. This is particularly true for stakeholders who have the same member serving on both the technical and administrative committees. Secondly, scientists and managers use terms differently, and there have been misunderstandings that have unknowingly arisen out of these differences. Such misunderstandings can erode trust and slow progress, so careful attention to ensuring that the intended meaning is conveyed is a constant necessity.

*How and when will the need for improvement be addressed, if at all?*

A roles and responsibilities ad hoc committee with representatives from all program groups was formed by the Secretary's designee, and the committee has produced a set of recommendations for improvement. Also, the science advisors to the GCDAMP, a standing body of eminent scientists, has undertaken an evaluation of the program to assess how well it is functioning to achieve the

goals and objectives set forth in the *Glen Canyon Dam Adaptive Management Program Strategic Plan*. It is a tribute to the stakeholders that they are willing to allow this in-depth look at how they and their supporting technical group and science institution are carrying out the tenets of AM. The science advisors' report will be completed by the end of 2006, and at that time, there will be an opportunity for stakeholders to identify better how they can further improve the use of AM to assist the Secretary of the Interior in making decisions on operation of Glen Canyon Dam and management of other factors negatively impacting resources in Glen and Grand Canyons.

#### **SOURCES OF INFORMATION/REFERENCES:**

- Bureau of Reclamation. 1995. Response to the Final Biological Opinion on Operations of Glen Canyon Dam (2-21-93-F-167). Memorandum from Regional Director, Upper Colorado Region, Salt Lake City, Utah, to Regional Director, Region 2, U.S. Fish and Wildlife Service, Albuquerque, New Mexico.
- Gloss, S.P., Lovich, J.E., and Melis, T.S., eds., 2005, The state of the Colorado River ecosystem in Grand Canyon. U.S. Geological Survey Circular 1282.
- Grand Canyon Protection Act of 1992. (Available at: <http://www.artsci.wustl.edu/~landc/html/gcpa1992.html>, accessed August 8, 2006.
- U.S. Department of the Interior. 1995. *Operation of Glen Canyon Dam Final Environmental Statement*. FES 95-98, March 21, 1995. Upper Colorado Region, Bureau of Reclamation, Salt Lake City, UT.
- U.S. Department of the Interior. 1996. *Record of Decision on the Operation of Glen Canyon Dam Final Environmental Impact Statement*. Upper Colorado Region, Bureau of Reclamation, Salt Lake City, UT.
- U.S. Department of the Interior. 2001. *Glen Canyon Dam Adaptive Management Program Strategic Plan*. Upper Colorado Region, Bureau of Reclamation, Salt Lake City, UT.
- U.S. Department of the Interior. 2002. *Environmental Assessment: Proposed Experimental Releases From Glen Canyon Dam and Removal of Nonnative Fish*. Upper Colorado Region, Bureau of Reclamation, Salt Lake City, UT; National Park Service, Glen Canyon Recreational Area and Grand Canyon National Park; U.S. Geological Survey, Grand Canyon Monitoring and Research Center, Flagstaff, AZ.
- U.S. Fish and Wildlife Service. 1994. *Final Biological Opinion Operation of Glen Canyon Dam as the Modified Low Fluctuating Flow Alternative of the Final Environmental Impact Statement Glen Canyon Dam (2-21-93-F-167)*. Ecological Services Arizona State Office, Phoenix, AZ.