



**THE GRAND CANYON MONITORING AND RESEARCH CENTER
LONG-TERM MONITORING AND RESEARCH STRATEGIC PLAN**

by

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Lawrence D. Garrett^{1/}
Barry D. Gold
Ruth Lambert

CHAPTER 1
HISTORY OF MONITORING AND RESEARCH
IN THE GRAND CANYON

The U.S. Department of the Interior (USDOI) Grand Canyon Monitoring and Research Center (GCMRC), was established by the Assistant Secretary for Water and Science in 1995. This draft, Long-term Monitoring and Research Strategic Plan (the Plan), is designed to implement, within the center, new concepts of adaptive management and ecosystem science, called for in the Grand Canyon protection act and the Glen Canyon Dam environmental impact statement. The strategic plan is designed to be a guidance document, from which an annual monitoring and research plan will be drafted. The first five year strategic plan, and derived annual monitoring and research plans will include extensive

^{1/}Lawrence D. Garrett, Barry D. Gold and Ruth Lambert are respectively Center Chief, Biological Resources Program Manager and Cultural Resources Program Manager of the Grand Canyon Monitoring and Research Center.

synthesis of past monitoring and research, as well as in depth programs for needed future ecosystem monitoring and research. This plan presents brief historical documentation of past science, as well as more in depth discussion of planned future strategies monitoring and research programs. An appropriate starting point is discussion of past science in the Grand Canyon.

SCIENCE IN THE GRAND CANYON

The first formal scientific investigations in the Grand Canyon and associated riverine area were conducted by John Wesley Powell (Powell 1869). Powell's scientific investigations included technical assessments of biophysical and cultural resources associated with the canyon, including the first ethnographic study of indigenous peoples. Powell's profound accomplishments resulted, in part, in the founding of the U.S. Geological Survey. Since Powell's initial investigation, significant science has been conducted in the Grand Canyon by many differing individuals, groups, and institutions.

In the first half of this century, economic interests paralleled scientific interest in the canyon. The Colorado River represented a significant opportunity to harness extensive hydroelectric power and provide water storage for growing agriculture and urban development in the Southwest. These interests culminated in construction of the Glen Canyon Dam in 1963, a facility that impounded over 25 million acre feet of water.

The Glen Canyon Dam was heralded as a wonderful resource for peoples of the Southwest. It was also criticized as a man-made instrument that would result in destruction of valued Colorado River resources, both above and below the Dam. Concerns over

potential damage to downstream resources have been persistent since 1963, and relate mostly to operating criteria proposed for power generation.

Widespread interest in the potential operating impacts of Glen Canyon Dam on river resources resulted in the establishment of the Glen Canyon Environmental Studies (GCES) Program by the Bureau of Reclamation (BOR) in 1982 (NRC 1987). That program operated until October 1996, and accumulated extensive research information on biophysical, cultural, and socio-economic resources. There has also been significant study of canyon resources by organizations and individuals not directly affiliated with the GCES Program. These projects were ongoing before establishment of the GCES program, and they have continued through the duration of that program. Unlike these projects, GCES had unified themes in several resource areas.

The GCES Program general mission was to investigate relationships between Glen Canyon Dam operations and changes in Colorado River resources throughout Grand Canyon (Howard and Dolan 1981, Turner and Karpiscak, 1980; Laursen et al. 1976, Dolan et al. 1974). Although some effects of flow regulation were relatively obvious in 1982, many other cause-and-effect relationships and ecosystem links between Glen Canyon Dam operations and the downstream river environment were poorly understood.

The GCES Program was conducted in two phases: Phase I from 1982-1988 and Phase II from 1990-1996. Phase I studies involved federal and state agency related research, with some studies and summary efforts extending to 1988. The program included descriptive studies of aquatic and terrestrial biology, avifauna, sediment-transport processes, hydrology, and recreational use. The results of Phase I research were presented as a series of single

discipline technical reports and publications (USDOI 1988a, 1988b). These studies confirmed that dam operations affected downstream resources. However, 1983 through 1986 were relatively wet years and the resulting reservoir spills limited scientific understanding of effects from fluctuating flows resulting from typical hydropower operations, the primary focus of the original research.

Following their review, the National Research Council (NRC) commented that despite extensive research during Phase I, the GCES single-discipline reports lacked integration, (NRC 1987). Information from the different disciplines had not been linked, and the resulting understanding of the system was therefore less complete than it could have been had the studies been integrated from the start. For example, information on hydrology and organic material in the water column had not been brought together with information on humpback chub diet to examine food availability over time and space. To provide deeper insight into the implications of initial research, documentation was prepared to summarize the results and conclusions of Phase I research (USDOI 1988b).

The NRC did conclude that the GCES Program demonstrated that impacts on Grand Canyon related to Glen Canyon Dam operations could be reduced (NRC 1987). In 1988, the DOI concluded that additional technical information was needed before dam operations could be modified in order to minimize impacts on downstream resources. A Phase II was then launched encompassing a broader base of resources, to respond to external criticism.

Phase II studies began in 1988. At the recommendation of the NRC, a senior scientist was appointed to provide direction and oversight for the overall GCES science plan (Patten 1991). However, shortly after Phase II studies began, the DOI mandated an environmental

impact statement on the operation of Glen Canyon Dam. The goals and schedule of Phase II studies were then modified and accelerated to support the environmental impact statement process. This redirection of Phase II studies eliminated aspects of integration that had originally been planned, in favor of rapid evaluation of areas of special concern for the environmental impact studies (Graf 1990, Webb et al. 1991, Melis and Webb 1993, Melis et al. 1994, McGuinn-Robbins 1995, Melis et al. 1995, Schmidt and Rubin 1995, Stevens et al. 1995, Stevens and Wegner 1995, Webb and Melis 1995, Webb 1996, Webb et al. 1996).

At present, relationships between the geomorphic framework of the Colorado River, including its hydrology, geology and sediment, and its aquatic and riverine habitats and related resources, are only generally understood despite considerable research efforts aimed at understanding the individual components of the river system.

Phase II studies have included research on sediment transport (e.g., Schmidt and Graf 1990, Andrews 1991, Cluer 1991, Cluer and Carpenter 1993, Schmidt 1993, Schmidt and Rubin 1995), organic drift (e.g., Angradi and Kubly 1994, Ayers and McKinney 1995), benthic ecology (e.g., Czarnecki and Blinn 1978, Blinn et al. 1994, Shannon et al. 1994), photosynthetically available radiation (e.g., Yard et al. 1993), water quality studies in Lake Powell (e.g., Stanford and Ward 1991, Ayers and McKinney 1996, Vernieu 1996), primary and secondary production in the Colorado River (e.g., Blinn and Cole 1991; Hardwick et al. 1992; Angradi and Kubly 1993; Ayers and McKinney 1995, 1996), diet of humpback chub (e.g., Carothers and Minckley 1981, Kaeding and Zimmerman 1983, Maddux et al. 1987, Kubly 1990), and overview studies (e.g., Carothers and Minckley 1981; Maddux et al. 1987; Angradi et al. 1992; Blinn et al. 1994, 1995; Angradi 1994).

The extensive data base and understanding developed as a result of GCES Phase I and Phase II activities provides a rich foundation of knowledge upon which the GCMRC program will build. The center is privileged to have that information as a starting point.

CHAPTER 2

CENTER PROGRAM JUSTIFICATION AND MISSION

The rich history of research noted briefly above, primarily the Bureau of Reclamation GCEIS Program, has provided significant assessment of impacts of dam operations on selected resources. Yet, interested parties and agencies who are charged to protect and manage these resources have now realized that effective protection and management will only be attained through a profound understanding of the interacting components of the system, offered via ecosystem assessments using both monitoring and research efforts. Further these efforts will be greatly enhanced if accomplished within a well structured adaptive management program.

Stakeholder concern over a need to understand impacts to canyon resources from an ecosystem perspective has resulted in the Adaptive Management Program (AMP) called for in the Grand Canyon Protection Act of 1992 (GCPA) (PL-102-575), and Glen Canyon Dam Environmental Impact Statement (GCEIS) (BOR 1995). The Act and EIS direct the Secretary of the Interior to **“establish and implement long-term monitoring programs and activities that will ensure that Glen Canyon Dam is operated in a manner consistent with that of Section 1802”** of the GCPA. **“Long-term monitoring of Glen Canyon Dam shall include any necessary research and studies to determine the effects of the Secretary’s actions under Section 1804 of the law on the natural, recreational, and cultural resources of Grand Canyon National Park and Glen Canyon National**

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Recreation Area.” The monitoring information is necessary 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.”

The Secretary’s actions shall be **“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 exploration of the waters of the Colorado River Basin.”** Actions of the Secretary will also be consistent with all other federal and state laws relating to resources, federal, tribal state, and local interests.

GCMRC MISSION

The EIS for future operation of the Glen Canyon Dam specifies the establishment of the (AMP) for assessment of Glen Canyon Dam alternative operating criteria defined in the Record of Decision (ROD) (BOR 1995), (USDOI 1996). The AMP includes the Grand Canyon Monitoring and Research Center (GCM&RC) and an Adaptive Management Work Group (AMWG).

The EIS specifies establishment of the monitoring and research center and the Adaptive Management Work Group (AMWG) within the AMP and defines it as a new approach in USDOI management direction. The AMWG includes representatives from federal and state resource management agencies, Native American tribes, and a diverse set of

other private and public stakeholders. The AMWG is appointed by the Secretary of Interior as a federal advisory committee to work cooperatively with the research center in implementing the AMP (BOR 1995). In adaptive management, the decision and management process is constantly evolving, with continuous input of new information to the Adaptive Management Work Group from the science center (Lee 1993).

The mission of the GCMRC is to determine short and long-term ecosystem resource impacts of alternative dam operation criteria^{2/} and other information needs specified by the Adaptive Management Work Group (AMWG), utilizing an ecosystem science paradigm. The GCMRC is mandated to inform the AMWG of resource protection, management and use implications of differing operations criteria.

^{2/}As defined in the Record of Decision of the Glen Canyon Dam EIS (USDOI 1996).

CHAPTER 3
SCIENCE PROGRAMING WITHIN
ADAPTIVE MANAGEMENT

Figure 3.1 contains a schematic of the Adaptive Management Program (AMP) and its critical entities, including the Research Center, now designated as the GCMRC. Following are the defined roles for other specified entities in the AMP.

Secretary of the Interior/Assistant Secretary for Water and Science/Designee: To assure that operating criteria for the Glen Canyon Dam provide appropriate protection, management and use of Grand Canyon National Park and Glen Canyon Recreation Area resources, as supported by scientific assessment.

Adaptive Management Work Group (AMWG): To provide to the GCMRC defined stakeholder objectives and criteria including specific information needs. To provide to the Secretary of the Interior recommendations on appropriate operating criteria for the Glen Canyon Dam.

Technical Work Group (TWG): To articulate to the GCMRC the science and information needs expressed in the objectives defined by the AMWG.

Independent Science Review Groups: To provide independent science assessments of proposed research plans and programs, technical reports and publications and other program accomplishments.

The Adaptive Management Program and processes for determining future operations of Glen Canyon Dam

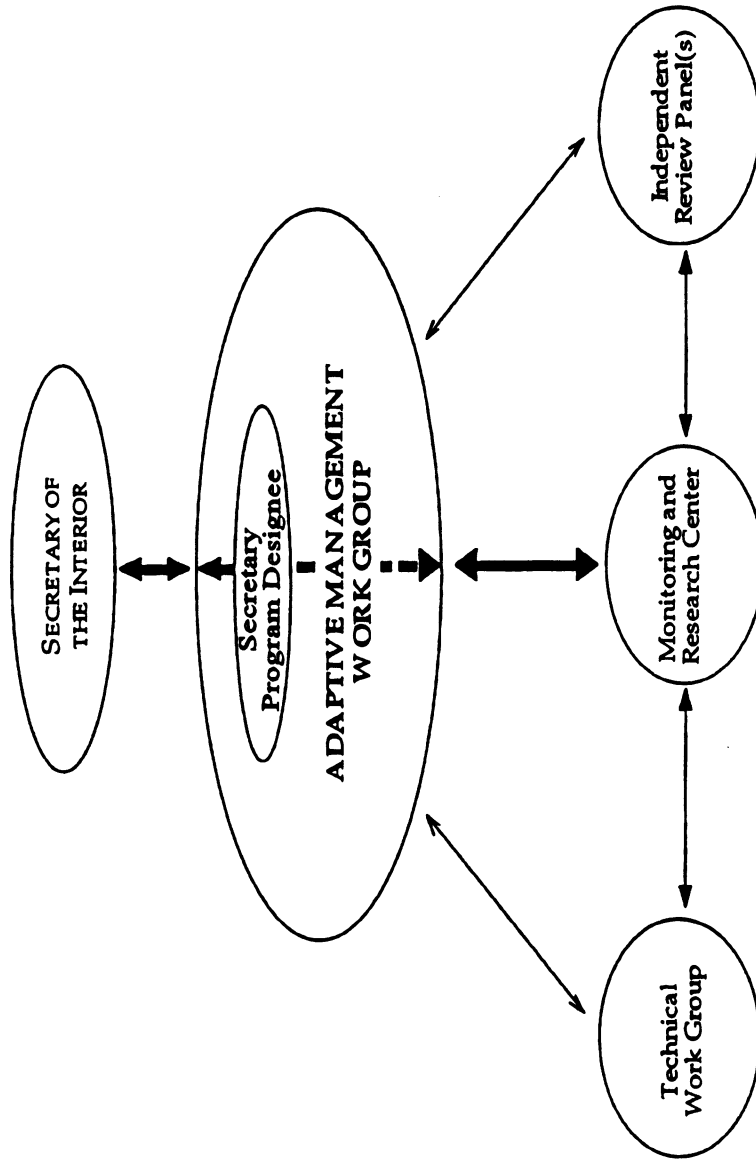


Figure 3.1. Adaptive Management Program Entities.

ADAPTIVE MANAGEMENT

Adaptive management begins with a set of management objectives and involves a feedback loop between the management action and the effect of that action on the system (Figure 3.2 [USFS & BLM, 1994]). It is an iterative process, based on a scientific paradigm that treats management actions as experiments subject to modification, rather than as fixed and final rulings, and uses them to develop an enhanced scientific understanding about whether or not and how the ecosystem responds to specific management actions.

The process begins with the definition of a series of management objectives defined by stakeholders and managers of the system. Once management objectives have been articulated and agreed to, management actions based on current “state-of-the-science” assessments can be taken to achieve these objectives.

An important interim step in this process is to allow for a dialogue between managers, stakeholders, and scientists who are knowledgeable about the system in question. Such a dialogue provides an opportunity for scientists to “reality-test” management objectives. That is, if managers wish to attempt to manage a system for a given outcome that is not feasible, it is important that they understand that at the outset. Experience has demonstrated that such a “scientific reality-testing” of management objectives leads to a better outcomes in the long-run. Bridging the culture between scientists, managers, and stakeholders takes commitment and effort.

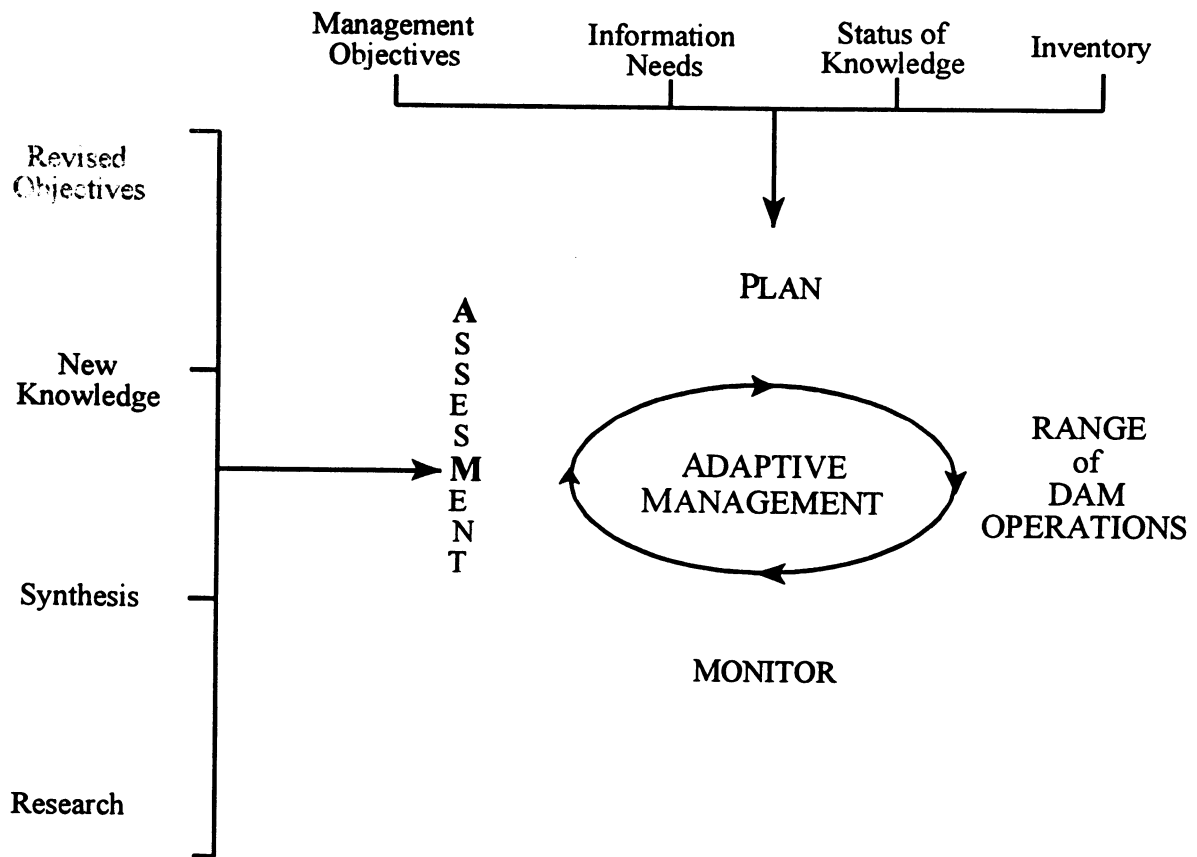


Figure 3.2: The Grand Canyon Monitoring and Research Center's approach to Adaptive Management (modified from USGS and BLM, 1994).