

**MANAGEMENT OF THE COLORADO RIVER
AT GLEN CANYON DAM:
A CASE STUDY FOR THE FUTURE?**

Presented at
American River Management Society
"Rivers Without Boundaries"
April 19, 1994

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ABSTRACT

Rivers without boundaries brings forth a connotation of a river system defining its own path and direction. Rarely do the rivers of today exhibit the freedom that made the river the unique place that it is. Today most rivers are constrained, physically, politically and emotionally between structures and people. The Glen Canyon Environmental Studies are used as a case study to discuss the role of science in the present and future management of Glen Canyon Dam on the Colorado River. An adaptive management program is being developed for the future operations of Glen Canyon Dam and the resources downstream. In the design of the adaptive management program a recommendation is made on the need to scientifically understand physical processes and ecosystem responses in order to preserve biodiversity and sustainable ecology.

INTRODUCTION

The rivers of the world are unique physical and biological systems which developed under situations far different than exists today. Rivers developed under the influence of changing hydrology, geology, biology and weather conditions. Today rivers are constrained and impacted by a far different process, those dictated by man! Today our rivers are under siege from developers, recreationists, researchers, managers, and the public. All believe they know what is best for the future of the river but few take the time to understand the river and the physical and biological forces that define it. Often short-term desire outweighs common logic and history and end up further harming the unique elements of the river system.

The theme of this symposium, "Rivers without Boundaries" has as an underlying precept the fact that rivers are important and require seeing beyond the traditional management methods to recognize that the future requires a more expanded, though not administratively simpler approach to management of river systems. An approach that recognizes that rivers are defined by processes and support biological communities that interact with the physical system, not circumvent it. Future river management must take into consideration focusing on sustainable ecosystem goals and retaining the biodiversity that is important for maintaining a healthy ecosystem.

The **objective** of this paper is to utilize a case study of the efforts ongoing in the Colorado River below Glen Canyon Dam as an example of how technical ecosystem information can be used to integrate into management of dam operations. Secondly we will discuss the importance of understanding biodiversity and river system dynamics in the development of sustainable ecosystem goals and the need for developing an **Adaptive Management** approach to future considerations at Glen Canyon Dam.

BACKGROUND

The Colorado River through the Grand Canyon is relatively young geologically speaking, forming its present course only within the last 40 million years. In comparison, the rock layers that the river has cut through are over 4.5 billion years old. The Colorado River is an isolated river system, resulting in endemic species that are low in number and unique in character. The majority of the fish and birds morphologically developed with few predators and therefore genetically never developed the in-grained ability to withstand predation or extensive competition.

The unique assemblage of plants and animals that developed both within and along the Colorado River developed slowly and conformed to the natural system rather than fighting it. The natural aspects of the Colorado River began to change in the late 1800's as settlers moved west and began to tap into the lifeblood of the West, the Colorado River. Early settlers did not control the river and understood that annual floods were a distinct possibility. That all changed in the 1930's as the era of big dams entered and the fight for the physical control of the Colorado River began. Hoover Dam was the first major total blockage of the Colorado River, but more were soon to follow, Glen Canyon, Flaming Gorge, Crystal, Blue Mesa, etc. Today over 43 structures control the plumbing of the Colorado River. Fourteen of the largest structures are managed and operated by the Federal government.

As the Colorado River came under the control of man, the unique physical and biological system came under direct attack and stood little chance for maintaining its historic relationship with the River. Now the river is changed. The boundaries are based on

administrative and political constraints, concrete and steel, and a veritable circus of exotic species of fish and plants. The historic hydrology, biology and geomorphology that defined the original river and determined the self sustaining populations is gone.

GLEN CANYON ENVIRONMENTAL STUDIES

The physical control of the Colorado River began before the age of NEPA and consequently the environmental and cultural concerns were never taken into consideration in the planning, building or operation of the dam and diversion facilities. Historically the only environmental type studies done were called "salvage studies" which focused on collecting cultural artifacts before the rising waters of the reservoirs drowned them. No scientific studies to ascertain antecedent or post dam conditions were initiated or completed. As a result many of the species and physical processes that defined the rivers below the dams were never evaluated, making today's job that much more difficult.

Glen Canyon Dam was no different. Glen Canyon was authorized by Congress on April 11, 1956 as part of a comprehensive Upper Colorado River basin water development project called the Colorado River Storage Project Act (Public Law 485). Construction of the dam began in the fall of 1956. The dam was essentially completed in 1963 and began to generate hydroelectricity in 1964. Glen Canyon is a multi-purpose project, supplying both water conservation for the upper Colorado River basin states and supplying a revenue flow from the sale of hydroelectricity to assist in financing the repayment of the dam and to support irrigation projects throughout the Upper Colorado River Basin. No concern was given to the resources downstream or how to operate the dam so as to take care of those unique resources. The building of Glen Canyon served as a primary consolidating force in the emerging environmental movement. Even now, Glen Canyon holds a special place in the environmental movement, a unique resource that represents both the best and the worst of the expanding United States.

Public concern over the impact of Glen Canyon Dam on the resources of the Grand Canyon continued to build and finally in the early 1980's rose to such a level that the Department of the Interior could no longer avoid looking at the impact the dam was having. On December 8, 1982 the Glen Canyon Environmental Studies (GCES) were initiated by the Department of the Interior to begin a scientific review of the impacts of Glen Canyon Dam and to ascertain whether any changes could be made to the operations to minimize those impacts. GCES was a cooperative effort from day One, with Reclamation taking the lead in administrative coordination and with the National Park Service, Arizona Game & Fish, the U.S. Geological Survey and academic institutions providing the primary technical support.

In 1989, the initial phase of the GCES program was completed and a series of technical reports were submitted to the resource agencies and the National Research Council. Based on these reports a recommendation was made to the Department of the Interior to initiate an operations EIS on the impacts of Glen Canyon Dam on the downstream resources of the Colorado River. The Draft EIS was recently released and to date over 30,000 letters of comment have been received. Obviously the public is still very interested in what is going on at Glen Canyon.

The second phase of the GCES program was initiated in 1989 to complement the EIS technical questions and to focus the research on a better understanding of the ecological relationships and physical processes in the Grand Canyon. This shift in emphasis was undertaken because we felt that the traditional process of research where focus is made on the "name" species or the broad ephemeral questions, was missing the real relationship between dam operation and the downstream resources. Presently there are over 100 special reports and ecosystem reports being developed to explain the unique ecological and cultural relationships in the Grand Canyon.

WHAT HAVE WE LEARNED? SCIENTIFIC LESSONS

Ecologically based management requires that a thorough understanding of the physical, biological, cultural, administrative and political boundaries be known. Without an understanding of the basics, development of an effective management roadmap is doomed to fail. The overall administrative goal of the GCES program is to provide the technical ecosystem based information, and analysis, to the decision-makers. The overall resource goal is to understand the Colorado River ecosystem in terms of the species, the ecosystem processes, and the biodiversity. There are three primary conclusions that we come to:

1. **Single-species or resource focuses do not do enough to understand and therefore ensure the productivity, maintenance and biodiversity of the Colorado River ecosystem through the Grand Canyon.**

We are dealing with an integrated resource ecosystem that is defined by cause-and-effect relationships and processes. Sustaining the ecosystem requires understanding the full understanding of it not just parts of it.

2. **The Colorado River ecosystem is dynamic and that it was formed by occasional disturbances which helped to sustain and enhance diversity on the micro-site level and also assisted in the process of competitive exclusion.**

This conclusion recognizes that floods, changing weather, changing interactions between species, and other changes in the

natural system assisted in the environment in defining itself. The key to future management is in understanding the importance of the antecedent conditions, post disturbance conditions and the thresholds for the present ecosystem. The goal then is to manage within the boundaries and thresholds, not to circumvent them.

3. **Science and Scientists can and should play a central role in describing the past, current and potential future conditions for ecosystem relationships. The data should be retained and maintained independent from the decision-environment.**

This conclusion points to the need that science and decision-making should be kept separate. Scientists can provide information but cannot make the decisions on how to manage the individual resources. That job is the responsibility of the managers and decision makers.

The GCES program has evolved from the broad-based, shot gun, reactive scientific approach of the 1980's to a process where the future will be based on a proactive, fine-tuned monitoring and research effort and one that will build on the basic scientific information and focus on the key thresholds and system relationships that define the ecosystem of the Grand Canyon. The future long-term monitoring and research program will be much reduced in field effort and will be developing innovative techniques to minimize the research impact in the Grand Canyon.

WHAT HAVE WE LEARNED? ADMINISTRATIVE AND MANAGEMENT APPLICATIONS

Now that the basic information on the impacts of Glen Canyon Dam on the downstream resources are identified, how are we going to use the information to more effectively manage the operations and the resources downstream? Will the GCES effort provide new boundaries for dam management or will the historic ways of managing the dam continue?

We have now catalogued the resources, made a first cut on how the resources are functionally related to the ecosystem, and can now focus our attention on how the dam operations influence them. We understand that the river is a continuum, and an ecosystem defined by the upstream, downstream, and overhead influences. There is no one dam operation or alternative strategy that fits all the needs. Bottom line, from a management perspective we must accept that environmental considerations must become integrated in the annual, seasonal and daily operations at Glen Canyon Dam and the rest of the Colorado River system.

The key questions that faces the river managers is how to integrate environmental and cultural management as a daily element in the operations of the dam? How do we jointly develop a management plan that takes into consideration the **dynamic nature** of

the ecosystem, the **dynamic nature** of the politics, the **changing management objectives** and the need for **real time** interfacing with the resource managers? How do we develop a management system that takes into account the old and new boundaries that define the Colorado River system?

The recommendation that has been proposed calls for inclusion of a process called Adaptive Management to be implemented as part of the Final EIS and subsequent operations of Glen Canyon Dam. Adaptive Management, very simply, is the concept of continually collecting additional ecosystem information and feedbacking that information back into the decision process on a real time basis so that management of the dam can be continually fine-tuned to the needs of the resources downstream. Adaptive management is predicated on an active feedback loop between the technical research and monitoring and the decision-makers. Presently the National Park Service and the Bureau of Reclamation are taking the lead on developing the adaptive management concept for the Glen Canyon Dam EIS for inclusion in the Record of Decision.

A specific scientifically ~~credible~~ long-term monitoring program is being developed which will provide the technical underpinnings for the adaptive management program. Future decisions on the operation of Glen Canyon Dam will finally take into consideration not only the historic water and power requirements but now include implementing ways to maintain and restore portions of the unique Colorado River ecosystem.

SUMMARY MANAGEMENT OF RIVER BOUNDARIES

We, as resource researchers and managers, are faced with an ever increasing, and alarming, array of often conflicting management guidelines. Guidelines that require us to work within the legal mandates that direct the historic goals of the management of the Colorado River system and equally important emerging environmental mandates directing us to work within a new set of boundaries, those that define broader reaching environmental and cultural goals. Our job is to find the balance between the legal needs and the ecosystem needs.

In order to achieve the goals of sustaining and preserving our delicate ecosystems we must increase our emphasis on ecosystem and river basin approaches to management over species-based approaches if we truly intend to maintain the majority of our existing biological diversity. The critical hurdle facing us in the river basin/riverine ecosystem approach is maintaining diversity and the reciprocating role of diversity in maintaining the historic uses of the river system. This requires a new and innovative approach to the management of the river and the dams that control it.

Maintaining the biodiversity and remaining uniqueness of the

Colorado River and the Grand Canyon requires an expansive view and approach to the management issues. Truly the Colorado River must be managed with all the parts included in the management matrix. The Colorado River is an extremely complex and functionally strangled river. We as managers and researchers must take the lead in showing the decision-makers that management of the Colorado River resources requires acceptance that the unique resources require stewardship of all of the species and the ecosystem processes and the integration of that knowledge into the management of the river system.

The Colorado River is currently fragmented into small segments, creating an environment with many boundaries, some more formidable than others. On a geologic perspective the dams and diversions are short-term however even short term impacts may cause the loss of unique and ecologically important resources forever. We cannot accept that loss. Managing the Colorado River requires that we manage the river as an integrated riverine ecosystem, understanding and working within not only the political and administrative boundaries but also within the biological and physical boundaries. Only then can we begin to focus on managing rivers without boundaries.