

# THE BUREAU OF RECLAMATION'S DIRECTIONS AND WATER RESOURCES EDUCATION NEEDS IN THE AGENCY'S 2<sup>ND</sup> CENTURY

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## **INTRODUCTION**

Today we are surrounded by many of the same natural resource debates of decades ago. The past year has seen power crises in California and a slowing economy dominate the financial discussion, while drought conditions in the West have pushed the Department of the Interior to allocate water supplies for instream flows and endangered species instead of irrigation. The debate is squarely between our life style standards and the protection of the ecological life support systems on which we depend.

Two primary challenges face modern decision-making in government -- the values we as a society espouse (i.e. our direction) and the way we use data to make decisions (i.e. our information needs). Within these issues lies the interface between science and management. Within the last 25 years, the concept of adaptive management has evolved as a process for that interface. Using the Glen Canyon Dam Adaptive Management Program as a case study, this paper examines that interface and the role that collaboration plays in managing the nation's resources and in so doing, defines the direction and information needs of Reclamation in its second century of existence.

## **THE DIRECTION OF RECLAMATION**

As a republic, the United States formulates public policy through the interaction of the Congress and each administration, both elected to represent the public. Budgeting and authorization processes supplement statutes in guiding individual agencies and, as a result, the direction and goals each agency pursues reflects the values of society.

Federal and state management agencies have delegated responsibilities for many of the natural resources in our nation. Authorities for these agencies are typically contained in statute, from which agencies develop policies. Government agencies rely on these statutes and policies as they make management decisions, and the public can depend on agencies to appropriately carry out their Congressional mandates, or initiate litigation to force agency compliance.

Watershed changes in agency direction usually only result from their response to crisis situations or from significant

political change. More commonly, agencies adapt to the passage of additional statutes with gradual changes in mission and goals. Such has been the case with Reclamation.

Since its inception in 1902, Reclamation has been tasked with the reclaiming of the arid lands of the 17 western States. This has involved the construction of irrigation and municipal water delivery facilities in most of the counties of the West, providing water and power resources that have allowed the colonization of an otherwise adverse environment. We can meet in Salt Lake City to discuss these issues only because life-sustaining water and power infrastructure exists.

There are indications that we are now reaching the limits of what these natural resources can sustain and many of the rivers of the West are fully appropriated. Just last week, PBS broadcast a special by Bill Moyer entitled "Earth on Edge." It documented the potential loss of our own life support infrastructure. Fifty percent worldwide loss of both wetlands and forests, and depletion of 70 percent of marine fisheries over the last century provide sobering acknowledgment that perhaps it is true that changes need to be made. The current issue of National Geographic documents that the per capita ecological footprint of the United States is many times larger than the rest of the world, meaning that we require more land to support our lifestyle.

Reclamation still responds to Congressional direction to develop new water supplies, particularly to satisfy tribal water right obligations. However, with increasing pressures on our projects, the focus of Reclamation has naturally turned from the construction of new projects to the management of existing projects. With this new focus, the need for scientific feedback on the impacts of our actions and alternative operational approaches is increasing.

## **SCIENTIFIC INVESTIGATION**

In contrast to the philosophic political debate that value systems engender, science is all about the process of discovering the "truth" of natural systems. It uses the scientific method, defined as "principles and procedures for the systematic pursuit of knowledge involving the recognition and formulation of a problem, the collection of

data through observation and experiment, and testing of hypotheses.” One envisions universities rather than governments when using this term.

There are fair questions to ask of the role of science in government decision-making, including, who should formulate the hypotheses? Who decides on how data is brought into the decision process? What role does risk analysis play as decisions are made? Defining roles in this interaction is crucial to successful integration. So, what role does science play in Reclamation’s future?

Throughout the mid-1900's, Reclamation established a worldwide reputation as a water development organization. Its contribution to the science of water resources is broad and deep, much as the flow of these mighty rivers. Our technical publications and laboratory work have paved the way for much of the world’s population to harness available water and hydropower resources.

Now, a better understanding of the effects of this development is needed. We leave an environment of calculated certainty, and enter an environment of unknowns and uncertainty. Addressing this uncertainty seems best captured by the concept of adaptive management.

## **ADAPTIVE MANAGEMENT**

“Adaptive management” was formulated in the last 25 years from the premise that experimentation, and the resulting increase in scientific understanding, would result in better government policy and decision-making. It was also seen as the most viable option to litigation as environmental protection was integrated into society. This latter purpose is particularly important since most environmental legislation has responded to perceived crises as modern society expands its influence on natural processes. Therefore, environmental legislation can be viewed as an overlay on existing social infrastructure and policy rather than a foundational basis for social evolution.

Even when legislation grants environmental protection a high priority, as in the Endangered Species Act, policy implementation and scientific evidence may bring conflict, uncertainty and lack of clarity when the overlay conflicts with established social infrastructure. In this setting, adaptive management entails a long-term process for accommodating new information. Lee (1993:9) notes that adaptive management applies the concept of experimentation to the design and implementation of natural resource and environmental policies. An adaptive management policy is one that is designed from the outset to test clearly formulated hypotheses about the behavior of an ecosystem being changed by human use. Its core characteristics are: (1) it addresses resources on an ecosystem level, rather than allowing isolation by artificial political boundaries or disciplines, (2) it considers all species and projects holistically rather than individually,

and (3) it uses a time scale of biological generations to allow impacts to be fully understood.

## **THE GLEN CANYON DAM ADAPTIVE MANAGEMENT PROGRAM**

Glen Canyon Dam was completed in 1963 as the keystone of the Colorado River Storage Project. Located 16 miles upstream of the demarcation line between the Upper and Lower Basins of the Colorado River, it serves as the major storage facility in the delivery of water between basins. Its primary role is to make these deliveries during drought periods when the natural flow of the river is insufficient without the reservoir. The sizing of the reservoir and the calculation of expected benefits were accurately performed, but in the pre-NEPA days of the 1950's, less attention was paid to the potential impacts downstream.

From the 1995 Operation of Glen Canyon Dam Final Environmental Impact Statement, increasing concern has been expressed by the public and Federal and State agencies about how Glen Canyon Dam operations may be adversely affecting downstream resources. In response to these concerns, the Secretary directed Reclamation to prepare an EIS on Glen Canyon Dam operations (U.S. Bureau of Reclamation, 1995).

Part of the selection of a preferred alternative in the 1996 Record of Decision was the inclusion of an adaptive management program, an atypical step in reaching a decision under the National Environmental Policy Act. It acknowledged the uncertainty of the effects of the proposed decision, even after nearly \$100 million of monitoring and research activity in the Grand Canyon. Clearly the downstream ecosystem was far more complex and unpredictable than expected.

### Organization

The adaptive management program consists of 26 stakeholders who represent a wide range of interests. They include the affected Basin States, seven Federal and State agencies, Indian tribes, power contractors, and recreation and environmental groups. Each stakeholder group is represented on a management group chartered under the Federal Advisory Committee Act and a technical analysis group. Their charge is to provide advice and recommendations to the Secretary of the Interior relative to the operation of Glen Canyon Dam and other management actions in meeting the downstream protection provisions of the 1992 Grand Canyon Protection Act. In addition to these groups, the program includes the Grand Canyon Monitoring and Research Center, which manages the scientific investigations, and independent review panels that provide scientific oversight.

## Processes

How a group pursues its efforts is often as important as what they are pursuing. We continually evaluate the success of interactions within these diverse stakeholder groups. The management and technical groups meet several times each year to evaluate the status of resources. They have prepared a strategic plan for conducting this work, which includes a vision/mission statement of their expectations of the downstream ecosystem. Further definition of target objectives for each resource allows direct comparison with current conditions to determine if the program is meeting the goals of the Glen Canyon Dam EIS and the Grand Canyon Protection Act. However, many of these numeric target levels remain unquantified because of the difficulty of addressing individual dynamic resources within an ecosystem objective.

The Grand Canyon Monitoring and Research Center administers a stable long-term monitoring program that is critical to understanding the status and trends of downstream resources. This effort uses repetitive measurements on a consistent time scale, but also uses random stratified sampling in an attempt to eliminate sampling bias. In contrast, the research program employs a hypothesis-driven approach to gain better understanding of ecosystem processes. Research projects typically require comparison with control, baseline, or “no action” conditions, attempting to isolate cause and effect relationships. This is particularly difficult since many factors other than dam operations contribute to impacts on downstream resources. Most of the scientific work is administered through contracts, accompanied by external peer review of both proposals and draft reports. This step ensures the highest quality objective science and independence from any stakeholder.

Numerous ad hoc groups are established to address specific topics or issues. These span the full range of program activities and usually involve stakeholders with specific expertise in each issue. These groups bring recommendations back to the technical and management groups for consideration and eventual recommendation to the Secretary.

Experimentation is key to the adaptive management program. While the basic concept of experimentation in water resource management may seem scientifically reasonable, the politics of experimentation are quite another story. The concept infers some departure from existing conditions, and many stakeholders view this as a threat, particularly when the adaptive management concept is overlain on an existing NEPA Record of Decision. Nevertheless, it is this area where the need for scientific understanding is most needed, and this type of sensitivity analysis helps address the appropriateness of our original decisions. Recent examples of experimentation include the nationally televised “beach habitat building flow,” in 1996,

a smaller magnitude “habitat maintenance flow,” in 1997 and a “low steady summer flow” in 2000. The purpose of each of these events was different, ranging from sediment conservation to native fish protection. How successful each of these experiments was and how long the impacts will last varies, but each contributed to our understanding of how altered river systems function and, in the future, each will contribute to a dam operation policy that attempts to meet both human and natural resource needs. Each of these events came with significant financial impacts to power customers, alleviated to some degree by legislation allowing these costs to be credited as if they were part of the project repayment. More tests are expected in the future, all in an effort to increase our ecological understanding.

## Resource Challenges

Clearly the two resource areas where new information has caused the biggest stir are sediment conservation and endangered fish. The sediment issue is important because the Glen Canyon Dam traps about 90 percent of the sediment that once flowed through the Grand Canyon; the remainder comes from tributaries in the Canyon downstream of the dam. With such a reduced contribution, it is not surprising that beaches and channel margin deposits have declined significantly since the closure of the dam. We once believed that by reducing power plant fluctuations, the export of sediment would be slowed and that sediment accumulated on the main channel bed could be redeposited as beaches by high flows. We are now finding that all but the very lowest flows export main channel sediment, and that high flows in the future may need to be timed with tributary inputs or full eddy deposits to allow sediment concentrations high enough to build beaches and retain sediment. By eliminating the extreme low and high power plant releases, the EIS decision effectively excluded both the retention of main channel sediment deposits and the high level deposition of sediment on channel margins and beaches. Experimentation will provide additional information to guide future decisions.

The Grand Canyon is home to the humpback chub, an endangered fish that is one of the targets of an extensive native fish recovery program in the Colorado River Basin. One of the strongest populations of the chub is in the Little Colorado River, a tributary in the Grand Canyon. By reducing power plant fluctuations, we believed the chub would benefit, but we are now facing the unintended consequences of this action. Certainly the aquatic productivity of the river has increased, but with an accompanying explosion in the non-native trout fishery, a predator of the chub. The trout population in the first 15 miles has now reached about 20,000 trout per mile, with perhaps a million trout in the remainder of the Grand Canyon. With this increased competition and predation risk, there are signs that the numbers of chub may be actually decreasing. Close coordination and consultation

with the fishery biologists will be required as we navigate this difficult issue, and great importance will be placed on solid science and the understanding of risk.

A last issue of controversy is of course funding. This adaptive management work is expensive, about \$8 million annually, and financed primarily from power revenues. This past year, Reclamation's appropriations bill capped the amount of power revenues available to the program, at a lower level than external review panels will likely recommend. The effect of this action will be a slower rate of learning or greater confidence bands on monitoring and research, the result of less frequent sampling. However, the program continues to move forward, attempting to understand the effects of our actions and improving the quality of our water management efforts. The Department of the Interior is committed to the program's success and views this effort as a potential model for additional efforts.

## CONCLUSION

Clearly our society continues to struggle with competing goals of resource development and protection. Collaboration between stakeholders forms the essential foundation upon which agreement can be built. Adaptive management is the process by which this construction can best occur, and the U.S. Bureau of Reclamation is committed to its use.

## AUTHOR

**Randall Peterson** graduated Magna Cum Laude from the University of Utah in 1978 with a B.S. in Civil Engineering. He has worked in the Department of the Interior with the Bureau of Reclamation for the past 23 years, working extensively on hydrologic estimations and risk-based decision-making. For 15 years he led Reclamation's operation of the mainstem Upper Colorado River Basin reservoirs, including Glen Canyon Dam. He was instrumental in modifying the operation of Glen Canyon Dam following the flood years of the 1980's to reduce the frequency of uncontrolled flooding, and in the mid-1990's led the negotiation of an agreement between the Department of the Interior and the Colorado Basin States allowing the 1996 test of the Beach/Habitat Building Flow, the widely publicized "spike flow" from Glen Canyon Dam. He has co-chaired the Colorado River Management Work Group, a public involvement group which is involved in the operation of the entire Colorado River reservoir system, and is currently the program manager of the Glen Canyon Dam Adaptive Management Work Group, a science-based collaborative effort which seeks to protect the resources of the Grand Canyon while meeting the project purposes of the dam.

## REFERENCES

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