October 19, 2011

TO: Members of the Technical Work Group

FROM: Jack Schmidt, Chief, Grand Canyon Monitoring and Research Center

RE: Some thoughts about the Glen Canyon Dam Adaptive Management Program and GCMRC's role in that program

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I have served as Chief for approximately two months, and have had conversations with some of you about the Glen Canyon Dam Adaptive Management Program (GCDAMP) and about GCMRC's role in that program. In conversations with Shane Capron and Mary Orton, I made a commitment to share with the Technical Work Group (TWG) some of my preliminary thoughts about the GCDAMP and the GCMRC. My attempt here is to provide thoughts that might spark a constructive conversation with TWG members. During the October 20 TWG meeting, there will be an opportunity for me to listen to your initial reactions. It is my intention to have follow-up conversations with each of you so that I can learn more concerning your opinions about the GCMRC and its work.

In 1997, the Secretary of the Interior created the GCDAMP and thereby established a framework for structured scientific decision making concerning the Colorado River ecosystem (CRE) between Glen Canyon Dam and Lake Mead reservoir. The GCDAMP includes five entities, each of whom has a defined role (*2008, Report and recommendations to the Secretary's Designee from the Roles Ad Hoc Group of the GCDAMP*): the Secretary's designee, the Adaptive Management Work Group (AMWG), the Technical Work Group (TWG), the Grand Canyon Monitoring and Research Center (GCMRC), and independent review panels.

The role of the GCMRC is well defined. The Center is "the provider and coordinator of research" for the adaptive management program and provides "credible, independent, and objective" science support concerning the effects of Glen Canyon Dam and related factors on the CRE. Although changes in the leadership of GCMRC present a challenge to the continuity of the GCDAMP, these changes also provide an opportunity to re-evaluate GCMRC's role in the adaptive management program.

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1. *The GCDAMP, by definition, is a program of adaptive management. Although there are other approaches to natural resource management, adaptive management is the approach being applied in the CRE, by decision of the Secretary of the Interior in 1997.*

   An adaptive management program, by definition, involves a program of rigorous scientific experimentation and analysis, and iterative adjustment of management decisions as scientific uncertainty is reduced.

Adaptive management places large responsibilities on both scientists and stakeholders. It is the job of scientists (a) to identify scientific uncertainties, (b) to develop monitoring programs that quantify the status of key resources, (c) to develop and characterize variation in the key environmental drivers of the ecosystem, (d) to develop experimental programs to resolve key uncertainties, (e) to analyze experimental and monitoring data to inform future management actions, and (f) to develop models that link potential management actions to resources consequences. It is the job of the stakeholders (a) to articulate clear, measurable, and agreed-upon objectives that guide decision making and can be used to assess progress in achieving management success, and (b) to identify the suite of potential management actions that are available to be used in the design of experiments. The literature also points out that adaptive management not only involve iterative experimentation, scientific analysis, and revision of management actions, but also iterative reevaluation of program goals, objectives, and range of potential management actions.

As you all know, adaptive management "is an approach to natural resource management that emphasizes learning through management, based on the philosophy that knowledge is incomplete and much of what we think we know is actually wrong" (*Allen et al., 2011, Adaptive management for a turbulent future: Journal of Environmental Management 92: 1339-1345*). Despite the existence of this uncertainty, managers and policy makers must make decisions, and the process of adaptive management seeks to decrease uncertainty through a structured process of experimentation. In contrast to management by trial and error, adaptive management is a formal iterative process with an explicit decision structure necessitating articulation of goals, management objectives, hypotheses of causation, data collection procedures, and subsequent evaluation and analysis, and reiteration (Fig. 1).

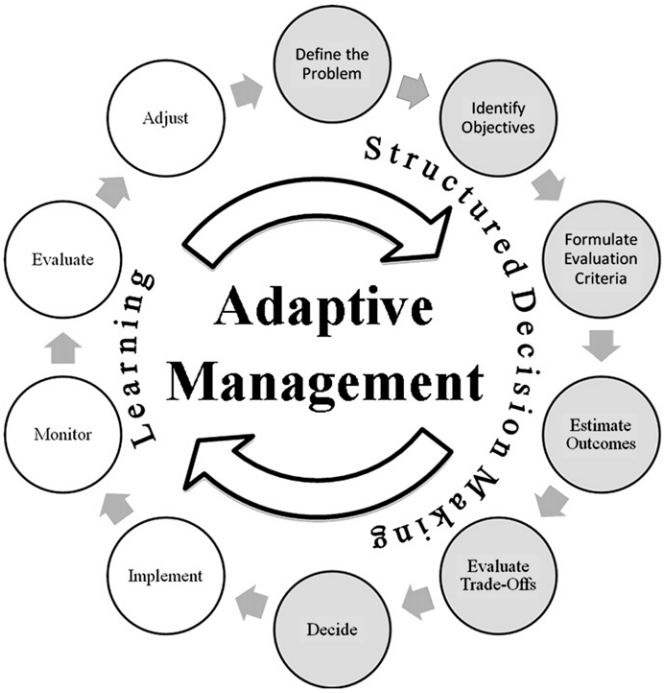

Figure 1. A representation of the adaptive management process that highlights the fact that adaptive management includes a decision component and an opportunity to learn. Structured decision making (SDM) is not necessarily the equivalent of adaptive management. SDM is simply an organized and transparent approach to the decision process. What makes adaptive management distinct from structured decision making is the inclusion of the iterative process of scientific learning that informs revisions of the decision process (*from Allen et al., 2011*). Although the GCMRC and the stakeholders participate in many parts of the cycle of adaptive management depicted in this diagram, GCMRC is primarily involved with activities on the left side of this circle.

Although the intellectual roots of adaptive management in natural resources management lie in fisheries management in the 1950s, the term gained wide visibility two decades later in an edited volume, *Adaptive Environmental Assessment and Management* (Hollings, 1978). Carl Walters, a long time advisor to the GCMRC and GCDAMP, further developed these ideas (*Walters, 1986, Adaptive management of renewable resources*), especially in the realm of mathematical modeling.

Adaptive management is considered an appropriate strategy for natural resource management where there is high scientific uncertainty and there is also a high degree of controllability of ecosystem drivers (Fig. 2). In the case of the CRE, discharge can be controlled to a high degree and temperature somewhat less so. In contrast, fine sediment can be controlled to a lesser extent because it is supplied from unregulated tributaries. The opportunity for experimentation is primarily provided by the controllability of discharge. In other managed ecosystems where controllability is high but scientific uncertainty is low, experimentation is less appropriate, and other management strategies might be employed, such as pursuit of maximum sustained yield. Other management techniques are appropriate where ecosystem drivers can only be poorly controlled, because experiments are more difficult to conduct in such an environment.

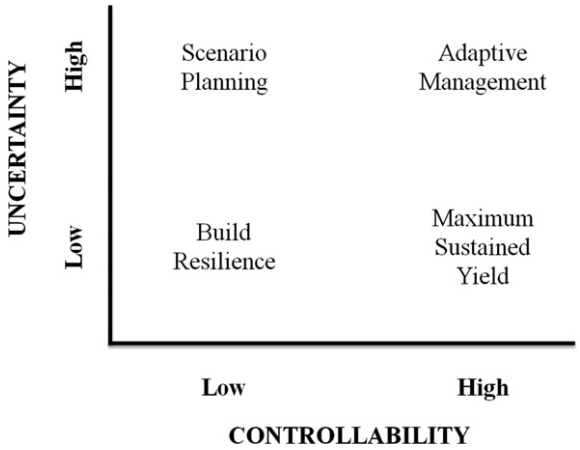

Figure 2. Adaptive management is an appropriate strategy where there is a high potential for learning and the system can be manipulated (*adapted from Peterson et al., 2003, Scenario planning: a tool for conservation in an uncertain world: Conservation Biology 17: 358-366, and reproduced by Allen et al., 2011*).

2. Applying adaptive management to the CRE is a challenge, because the certainty of law and its administrative application greatly constrains the types of experimentation that otherwise would be pursued based on adaptive management theory. The GCDAMP, at present, probably is better characterized as what some call "adaptive management-lite" – adaptive management constrained by a significant body of law and administrative rules. Some agencies and stakeholders express frustration about GCMRC proposals for continued substantive monitoring, research, and experimentation, but this type of work is essential to the practice of adaptive management. If stakeholders consider the present uncertainties in understanding ecosystem processes or in predicting the outcome of management actions to be small, then an alternative approach to adaptive management could be considered.

There is a significant challenge to meshing adaptive management with the role of law in the United States' system of governance. In some cases, the certainty of law and the inherent rigidity of institutions limits the types of experimentation needed to resolve scientific uncertainties (*Garmestani et al., 2009, Panarchy, adaptive management and governance: policy options for building resilience. Nebraska Law Review 87: 1036-1054*). Ruhl and Fischman (*2010, Adaptive management in the courts. Minnesota Law Review 95(2): 424-484*) have observed that the two-step process of U. S. administrative law (i.e., a first step that allows public comment on draft documents and the second step of a final agency action that creates "certainty" to the process and provides the opportunity for judicial review) is in fundamental conflict with adaptive management, because the law requires certainty but adaptive management is "based on the realization of dynamic systems characterized by surprise." Karkkainen (*2005, Panarchy and adaptive change: around the loop and back again. Minnesota Journal of Law, Science & Technology 7: 59-77*) and Ruhl (*2008, Adaptive management for natural resources – inevitable, impossible, or both? Rocky Mountain Law Institute 54(11): 1-6*) have asked if adaptive management might be impossible under the current framework of administrative law.

Allen et al. (2011) observed:

> In effect, administrative agencies in the USA do not conduct adaptive management as it was originally conceived (Ruhl and Fischman, 2010). Rather, agencies conduct "adaptive management-lite", as the courts have provided some leeway for adaptive management projects, provided they have requirements that are legally enforceable (Ruhl and Fischman, 2010). The primary problem with adaptive management-lite is that it does not measure up to the standards of adaptive management theory, nor does it hold up under the scrutiny of substantive and procedural law (Ruhl and Fischman, 2010). Thus if adaptive management is necessary for good environmental management, environmental law must be "adapted" to fit with adaptive management (Ruhl, 2008).

In light of the extensive legal and administrative history that has resulted in the Law of the River, it is not surprising that there is, at times, significant disagreement and debate about how the GCDAMP ought to function in practice. Additionally, there is disagreement about how the program operates in relation to other laws, such as the Endangered Species Act, and to the responsibilities of land, water, and energy management agencies who are also stakeholders. It is not surprising that some stakeholders express frustration with the experimental approach inherent in adaptive management, when they yearn for the certainty of agency action.

GCMRC should not be blamed for pursuing a systematic approach of monitoring and measurement, research and experimentation, and data analysis. Nor should GCMRC be blamed for suggesting new experiments. Resolving uncertainty is the essence of adaptive management. However, GCMRC needs to do a better job of framing its scientific work in terms to explicitly describing the nature of existing scientific uncertainty and how future experiments, monitoring, or data analysis might reduce that uncertainty. GCMRC should also strive to articulate the implications of various management actions in relation to that uncertainty.

In the event that stakeholders declare that the present level of scientific and management uncertainty is acceptably small, then consideration ought to be given to abandoning adaptive management as the desired approach to natural resources management in the CRE. In the meantime, scientific data collection and reanalysis of scientific paradigms, including proposals for new experiments, will be the work of GCRMC; it is part of the Center's job.

3. The fundamental job of GCMRC is to provide "world-class science" input to the GCDAMP process, while providing planning support to the TWG and conducting its business in a transparent and economical way. GCMRC is committed to identify ways to increase its productivity so as to meets these obligations. Consideration ought to be given to reevaluating the nature of planning documents developed by GCMRC in support of TWG activities.

Various administrative documents, including the *Report of the Roles Ad Hoc Group*, GCMRC's *Strategic Science Plan*, and GCMRC's *Monitoring and Research Plan,* discuss the organization and size of GCMRC required to carry out

its functions as a provider and organizer of science. These documents establish an expectation that GCMRC conduct or supervise science activities that are consistent with "the world-class quality of USGS science products." There has been disagreement, however, about the desired size of the GCMRC staff.

There has also been disagreement about the relative amount of scientific work conducted by GCMRC staff in relation to work conducted by contractors, cooperators, other agencies, and universities. Regardless of who conducts this work, GCMRC is charged with having its scientific activities (proposals, contract awards, final reports) reviewed by independent peer panels. The sum of these activities is captured in the Strategic Science Plan's description of the job of the GCMRC Chief – to ensure quality science is conducted on priority issues in a timely manner and in a cost-effective way.

As described in #2, the challenge of the GCDAMP is the challenge of conducting an adaptive management program in an environment constrained by laws and administrative policies that limit experimentation, impact some of the resources under study, and impact the experience of some visitors to the CRE. The challenge of GCMRC also involves the conflict of how to meet its goal of *conducting and organizing* world class science while at the same time providing sufficient administrative support to assist the AMWG and TWG in conducting its work. Presently, GCMRC is charged with developing and updating its Strategic Science Plan, Monitoring and Research Plan, Core Monitoring Plan, Biannual Work Plan, and to write annual reports, a 5-year summary of the status of CRE resources (i.e., SCORE report), and a report on the status of knowledge of various ecosystem processes. Additionally, GCMRC is charged with serving on every ad hoc committee of the TWG and is expected to actively participate in discussions and meetings wherever its scientific findings are used in legal or administrative actions, such as Environmental Assessments and rulings concerning fish or wildlife.

I am apprehensive that the goals of providing world-class science support and providing a significant number of planning documents are in conflict. Although I do not think that GCMRC should abandon its responsibilities to provide support for the work of the TWG, I do think that GCMRC and the TWG ought to reconsider the magnitude of planning documents and administrative reporting that is expected of the organization.

As Chief, I am committed to doing my part to identify ways to restructure the Center so as to increase productivity of the organization. I have no doubt that we can structure our organization so as to produce wider visibility for our scientific activities that in turn yields more critical peer-review about our program. On the other hand, I do think that it is imperative for the TWG and GCMRC to continue conversations about the nature of the planning documents needed by the TWG to meet its responsibilities.

4. The study area that is the focus of GCMRC's work has consistently been described as extending from Glen Canyon Dam to Lake Mead, but the primary focus has been on the mainstem Colorado River. Expanding the geographic scope

of GCMRC research activities would greatly improve the scientific and management perspective provided to the GCDAMP.

There is a long history of stakeholder discussion about the geographic scope of GCMRC. There is precedence for studies in Cataract Canyon, located upstream from Lake Powell reservoir on the mainstem Colorado River, but the vast majority of GCMRC's work has focused on the CRE between Glen Canyon Dam and Lake Mead. Most of that work has been conducted on the mainstem of the Colorado River. For example, it has been more than a decade since any ecosystem process level studies have been conducted on humpback chub in the Little Colorado River. Nevertheless, the key to understanding trends in native fish populations would well lie in understanding the tributaries better.

Thus, consideration ought to be given to expanding the horizons of GCMRC research beyond the presently defined CRE. The presently defined study area limits the perspective of GCMRC scientists in the conduct of their work. Such an expansion in research perspective would provide GCMRC and the GCDAMP the opportunity to place the issues of Colorado River science and management in Grand Canyon in a larger perspective and thereby increase the quality of science support provided to the GCDAMP.

Such a wider perspective is already held by some of the stakeholders. The Bureau of Reclamation's Upper Colorado River region not only includes Glen Canyon Dam but also includes the rest of the Upper Colorado River basin and the Rio Grande. The Western Area Power Administration distributes power for produced by all the power plants of the CRSP. The USFWS is organized into separate regions that divide the Colorado River basin in two parts. Agency staff who participate in the GCDAMP inevitably bring with them a larger regional perspective when they evaluate the management issues of the CRE in Grand Canyon, yet other stakeholders have more limited geographic perspective. I think that the GCDAMP and the Secretary's designee would be better informed if the GCMRC science program regularly placed issues of Grand Canyon science into a broader context.

5. Final thoughts …

As Chief of GCMRC, I am searching for ways to achieve the mandate that GCMRC be a "world class" scientific organization. I do not know how GCMRC can recognize world-class science unless the Center has staff of the same caliber. As an agency, it is essential that we must "walk the walk" if we are going to "talk the talk."

I do not think that GCMRC must be proficient in every aspect of applied river science, but I do think that the Center must identify its strengths and the areas in which it strives to be a national leader. In so doing, we establish a cohort of staff who can provide advice and interpretation of cutting edge science activities in a broader range of fields. Thus, my sense is that the GCDAMP would be best served by a GCMRC staff that included a significant cohort of national leaders in applied river science and its application to adaptive management. My challenge is to channel the energy and commitment of my staff,

to expect higher scientific productivity of some and to have other staff members provide more insightful scientific guidance to the adaptive management process.

The proof of the success of the GCDAMP program is implementation of new operating plans for Glen Canyon Dam and/or implementation of new on-the-river-and-on-the-ground management actions that improve CRE resources in desirable ways. The success of the program is not measured by the planning documents or the science papers that we write. However, the standard of American science that makes it among the very best in the world today is the peer-review process of publication in science journals and the written communication with our science and management peers. My job, as GCMRC Chief, is to push my staff to conduct its work consistent to the highest standards of American science. My job is also to provide meaningful science products to the GCDAMP that ask, "How well do we know that process?" "Is there an alternative hypothesis?" "Could we be wrong?" Such constant second-guessing is the essence of adaptive management. Such an effort is also potentially maddening to policy makers, but that is the course chosen for us by the Secretary of the Interior. In the end, I think that course will serve us well.