DRAFT

GRAND CANYON MONITORING AND RESEARCH CENTER
STRATEGIC SCIENCE PLAN
TO SUPPORT
THE GLEN CANYON DAM ADAPTIVE MANAGEMENT PROGRAM

by

GRAND CANYON MONITORING AND RESEARCH CENTER

in cooperation with the

GLEN CANYON DAM ADAPTIVE MANAGEMENT PROGRAM

May 5, 2006

TABLE OF CONTENTS

GRAND CANYON MONITORING AND RESEARCH CENTER STRATEGIC SCIENCE PLAN TO SUPPORT THE GLEN CANYON DAM ADAPTIVE MANAGEMENT PROGRAM

PURPOSE AND BACKGROUND

Purpose

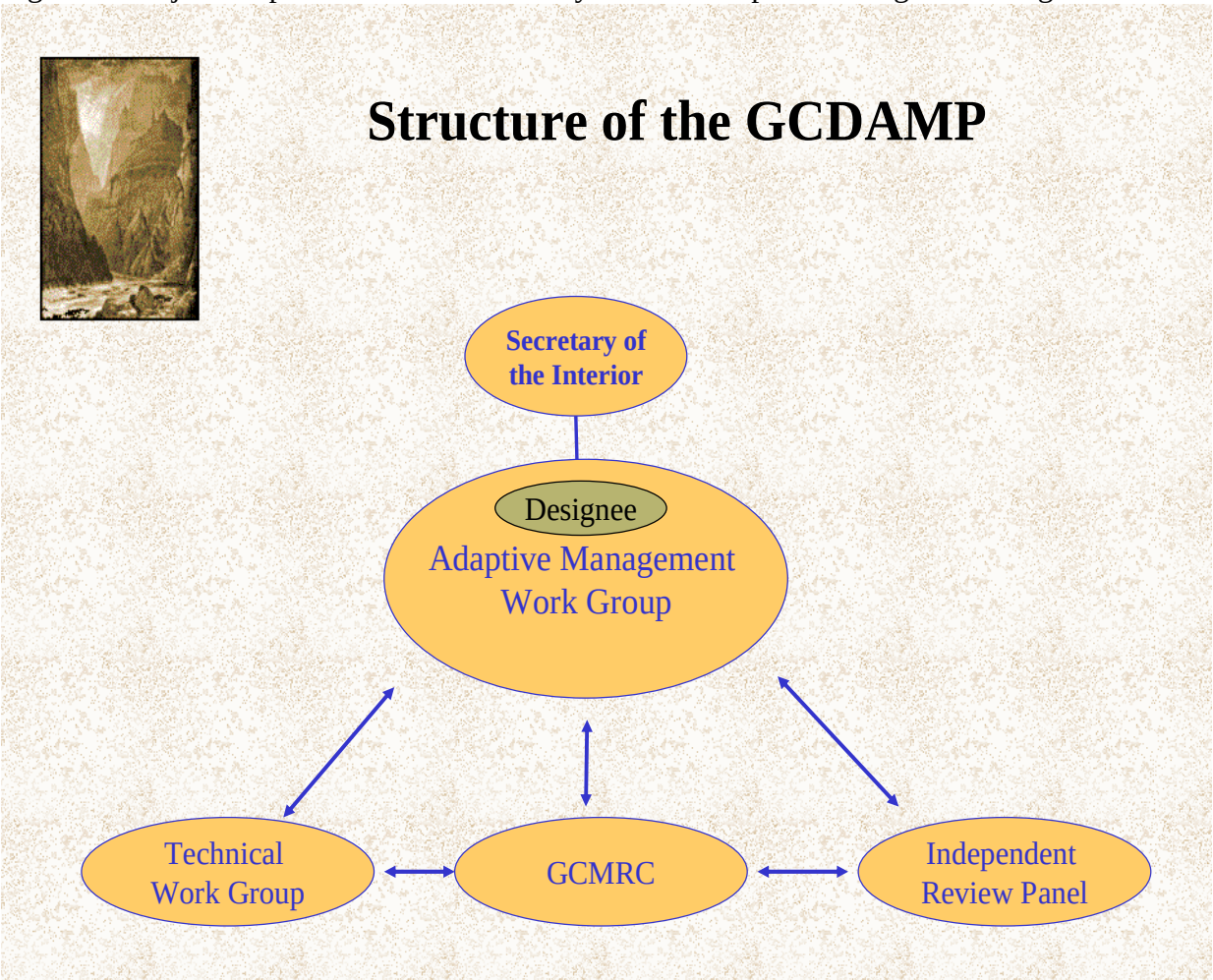
The mission of Grand Canyon Monitoring and Research Center (GCMRC) is to provide credible, objective scientific information to the Glen Canyon Dam Adaptive Management Program (AMP) on **(a)** the effects of the operation of Glen Canyon Dam (GCD) and other related factors on resources of the Colorado River Ecosystem (CRE) using an ecosystem approach, and (b) the flow and non-flow measures to mitigate adverse effects. The purpose of this Strategic Science Plan (SSP) is to identify strategies that will be pursued by GCMRC over the next 5 years to achieve this mission in cooperation with participants in the AMP.

Background

Section 1802 of the Grand Canyon Protection Act 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 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 AMP was established in 1996 by the Secretary of the Interior to implement the 1992 Grand Canyon Protection Act, the 1995 Glen Canyon Dam Environmental Impact Statement, and the 1996 Record of Decision. The AMP consists of five major components (Figure 1):

- **An Adaptive Management Work Group (AMWG)**. The AMWG is a 25-member Federal Advisory Committee Act committee that was established to oversee/guide implementation of the AMP. It reviews/develops alternative dam operations and related conservation measures and provides recommendations to the Secretary of the Interior.
- The **Secretary of the Interior's Designee** serves as the chair of the AMWG and provides a direct link between the AMWG and the Secretary of the Interior.
- A **Technical Work Group (TWG)** translates AMWG policy and goals into information needs, provides questions that serve as the basis for long-term monitoring and research activities, and conveys research results to the their AMWG member.

Figure 1. Major components of the Glen Canyon Dam Adaptive Management Program.



- The **USGS Grand Canyon Monitoring and Research Center (GCMRC)** provides credible, objective scientific information on the effects of the operation of Glen Canyon Dam and their related factors on natural and cultural resources along the Colorado River from Glen Canyon Dam to Lake Mead. Specific roles/responsibilities of GCMRC are outlined in Table 1.
- **Independent Review Panels (IRP)** provide independent assessments of program proposals and accomplishments to ensure scientific objectivity and credibility. Included in the IRP is a Science Advisory Board consisting of academic experts in fields germane to studies within the scope of the AMP.

The AMP is based on an Adaptive Environmental Assessment and Management (AEAM) approach to natural resources management that was developed in the 1970s (Holling 1978, Walters 1986). The approach is based on the assumption that managed natural resources will always change and our understanding of ecosystems is constantly improving, therefore, managers must be able to adapt to changing situations. AEAM was also developed to bring together the strengths of different scientific disciplines to bear on solving resource issues and to bring together scientists and managers rather than separate them.

AEAM has two related parts-- adaptive assessment and adaptive management. The assessment phase identifies different concepts of how ecological systems work and evaluates possible alternative actions that managers can implement. The management phase involves learning by doing/testing which may include monitoring of system responses to natural changes (passive adaptive management), or by deliberate manipulation of key processes (active adaptive management). Adaptive management acknowledges that policies must satisfy social objectives, but also be flexible to adapt as both understanding and the managed systems change. Managers who are actively involved in AEAM learn more about how the system works and how their actions change the system and thus, will be better able to manage in a complex and uncertain environment.

The SSP is based on a specific AEAM approach that has been articulated by the AMP in its draft strategic plan, which includes the following elements:

1. Models are developed to reveal the potential effects of policies, activities, or practices that are being considered for implementation;

2. Questions are formulated as testable hypotheses regarding the expected responses or linkages of the Colorado River ecosystem to dam operations and other management actions;

3. Experiments are conducted to test hypotheses and answer questions;

4. Management activities reveal, through monitoring and evaluation of results, the accuracy or completeness of the earlier predictions; and
5. New knowledge and information produced through experimentation are incorporated into management discussions and recommendations to the Secretary of the Interior.

Table 1. Roles and responsibilities of GCMRC.

1. Advocate quality, objective science and the use of that science in the adaptive management decision process.

2. Provide scientific information for all resources of concern identified in the "Operation of Glen Canyon Dam Final Environmental Impact Statement."

3. Support the Secretary's designee and the Adaptive Management Work Group in a technical advisory role.

4. Develop research designs and proposals for implementing monitoring and research activities in support of information needs identified by the AMWG.

5. Coordinate review of the monitoring and research program with independent review panel(s).

6. Coordinate, prepare, and distribute technical reports and documentation for review and as final products.

7. Provide regular reports to the AMWG/TWG on new scientific findings and their application to the AMP. Prepare and forward technical management recommendations and annual reports to the TWG.

8. Manage all data collected as part of the AMP. Serve as a repository for data/information about the effects of operating GCD and other related factors on the downstream resources of the Colorado River ecosystem.

9. Administer research proposals through a competitive contract process, as appropriate.

10. Manage GCMRC finances and personnel efficiently and effectively.

AMP PRIORTIES AND THE SCIENCE PLANNING PROCESS

AMP Management Goals and Priorities

The Final Draft AMP Strategic Plan identifies 12 goals for the program (Table 2). In August 2004, the AMWG reviewed these goals and identified priority questions to help guide the AMP Science program. The top five priority questions were:

- **AMWG Priority 1**: Why are the humpback chub (HBC) not thriving, and what can we do about it? How many humpback chub are there and how are they doing?

- **AMWG Priority 2**: Which cultural resources, including Traditional Cultural Properties (TCPs), are within the Area of Potential Effect (APE), which should we treat, and how do we best protect them? What is the status and trends of cultural resources and what are the agents of deterioration?

- **AMWG Priority 3**: What is the best flow regime?

- **AMWG Priority 4**: What is the impact of sediment loss and what should we do about it?

- **AMWG Priority 5**: What will happen when a Temperature Control Device (TCD) is tested or implemented? How should it be operated? Are safeguards needed for management?

GCMRC will use these questions as the primary (but not exclusive) basis for designing the science program for the next 5 years. Other sources of information that will be considered include:

- AMWG Management Objective and associated Information Needs (including CMIN ranking by the Science Planning Group),

- Protocol Evaluation Panel (PEP) recommendations,

- Knowledge Assessment report findings and recommendations, and

Table 2. AMP program goals as identified in the Draft AMP Strategic Plan

1. Protect or improve the aquatic food base so that it will support viable populations of desired species at higher trophic levels.

2. Maintain or attain viable populations of existing native fish, remove jeopardy from humpback chub and razorback sucker, and prevent adverse modification to their critical habitats.

3. Restore populations of extirpated species, as feasible and advisable.

4. Maintain a naturally reproducing population of rainbow trout above the Paria River, to the extent practicable and consistent with the maintenance of viable populations of native fish.

5. Maintain or attain viable populations of Kanab ambersnail.

6. Protect or improve the biotic riparian and spring communities, including threatened and endangered species and their critical habitat.

7. Establish water temperature, quality, and flow dynamics to achieve the AMP ecosystem goals.

8. Maintain or attain levels of sediment storage within the main channel and along shorelines to achieve the AMP ecosystem goals.

9. Maintain or improve the quality of recreational experiences for users of the Colorado River ecosystem, within the framework of the AMP ecosystem goals.

10. Maintain power production capacity and energy generation, and increase where feasible and advisable, within the framework of the AMP ecosystem goals.

11. Preserve, protect, manage, and treat cultural resources for the inspiration and benefit of past, present, and future generations.

12. Maintain a high quality monitoring, research, and adaptive management program.

- Fish and Wildlife Service (FWS) biological opinion requirements related to the operation of GCD

- Section 106 and 110 programs of National Park Service (NPS) and US Bureau of Reclamation (USBR)

In addition, GCMRC will propose at least one science project for each AMP goal (Table 2). This will promote a more balanced AMP and ensure that all key resources are addressed by the science program.

Science Planning Documents and Process

The GCMRC will design and implement the AMP science program in coordination and cooperation with the various AMP groups. Interaction between GCMRC and the AMP shall occur primarily in the context of four key documents:

1. The Final Draft **AMP Strategic Plan (AMPSP):** A long term plan drafted by AMP participants in cooperation with GCMRC in August 2001 that identifies the AMWG's vision and mission statement, principles, goals, management objectives, information needs and management actions (http://www.usbr.gov/uc/rm/amp/strategic_plan.html).

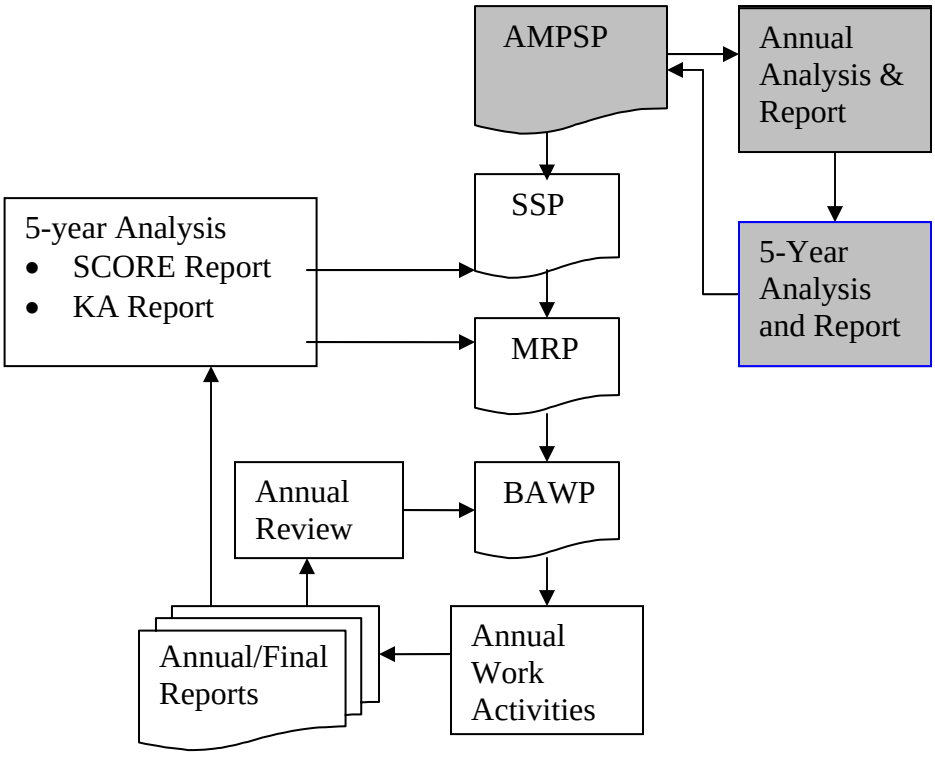
2. **The GCMRC Strategic Science Plan: (SSP):** Developed by GCMRC in cooperation with AMP participants to identify 5-year strategies for providing science information to respond to goals, management objectives and priority questions of the AMP participants, consistent with the AMPSP (this plan).

3. The **GCMRC Monitoring and Research Plan: (MRP):** Developed by GCMRC in cooperation with the AMP to specify 5-year research and monitoring programs consistent with the strategies and priorities in the SSP. The MRP will identify the objectives associated with each strategic science question and related monitoring, experimental research, and research and development projects.

4. The **GCMRC Biennial Work Plan: (BAWP):** Developed by GCMRC in cooperation with the AMP Science Planning Group, to identify the scope, objectives and budget for the 2-year monitoring and research projects consistent with the MRP.

Figure 2 depicts the flow of information in the science planning and implementation process. Annually, GCMRC will report on accomplishments related to projects included in the biennial work plan and evaluate how science has advanced knowledge relative to AMP goals and management objectives. At 5-year intervals, GCMRC shall formally synthesize new scientific information and knowledge in the form of an updated State of the Colorado River in the Grand Canyon (SCORE) report (Gloss and others, 2005) Knowledge Assessment Report (Melis and others, 2006) and/or other reports, as appropriate. Priority information needs and science questions will be evaluated by

Figure 2. Collaborative science planning and implementation process. The AMP and DOI have lead responsibility for the shaded boxes. GCMRC has lead responsibility for the unshaded boxes.



scientists and managers to determine what program revisions are needed. This includes development of revised SSP and MRP documents.

The GCMRC science planning will be most effective if it is done in conjunction with a periodic review of the AMP Strategic Plan including priority goals, information needs, management objectives and management actions/treatments. Completing concurrent reviews will help ensure the science program is properly aligned with current management objectives and priorities.

SCIENCE STRATEGIES TO ADDRESS PRIORITY AMP NEEDS

This Strategic Science Plan is based on the adaptive management paradigm, wherein new science information is continually cycled into application by managers, and outcomes are monitored by scientists and managers for effectiveness. This adaptive management process requires highly focused applied science projects which address specific management information needs. Consistent with the adaptive management paradigm, GCMRC's science strategy will emphasize the following elements:

- Interdisciplinary integrated river science
- Building bridges between science and management
- Strategic science questions to address priority AMWG goals/questions
- Critical research and monitoring needs outside the scope of the AMP

Interdisciplinary Integrated River Science

> "*The hydrologic cycle, in concert with human activities and geological, biological, chemical, and climatic processes, controls most of the commonly recognized features of rivers, such as river form, seasonal variations in flow, chemical quality, and the type of living resources in rivers." (USGS 2004)*

The GCMRC will increase its emphasis on employing an interdisciplinary integrated science approach over the next 5 years. An interdisciplinary integrated approach can better support AMWG's goals for how to best manage and sustain competing resource values to benefit both humans and the natural ecosystems to which humans belong. This means that single resources (and their research programs) will not be studied in isolation from other resources or from the socio-cultural context. Interdisciplinary integrated river science will be aimed at understanding and ultimately predicting how the resources respond to human activities, outside forces, and internal natural ecosystem drivers e.g., floods, drought, plankton blooms, etc. Understanding will come through and Experimental Research (ER), Core Monitoring (CM), and Research and Development (R&D). Prediction will come from a synthesis of findings in a quantitative modeling framework.

In 1998, Walters and others conducted an Adaptive Environmental Assessment and Management Workshop to assist Grand Canyon scientists and managers in development of a conceptual model of the CRE affected by GCD operations. The model proved to be useful at identifying knowledge gaps and predicting the response of some ecosystem components to policy change. However, the unavailability of data limited its effectiveness in several key areas such as long-term sediment storage, fisheries responses to habitat restoration, and socio-economic effects. Several improvements to the model to increase its utility in science planning and management processes have been suggested to make it more user friendly to scientists and managers, to provide information that is relevant to each high priority AMWG goal/question, and to incorporate advanced statistical and mathematical methods.

The GCMRC advocates that the AMP Science Advisors be tasked in FY 2007 with the identification and evaluation of opportunities for incorporating an interdisciplinary/ integrated ecosystem science and modeling approach into the current science program, including the refinement and use of conceptual and predictive ecosystem models and decision support tools. The feasibility of various approaches should be assessed based on the information needs of CRE managers, its utility in designing an integrated interdisciplinary science program for the AMP, and implementation costs.

Building Bridges between Science and Management

The GCMRC's ability to design studies that will produce relevant scientific information depends on how well the AMP managers clearly define and agree on resource goals, management objectives, and desired outcomes. To be successful, GCMRC scientists and AMP managers must work together as partners— partners that recognize each have distinct but complementary roles. These individual roles and responsibilities, outlined generally below, should be completed in a collaborative manner between the AMP managers and GCMRC. A more complete discussion of roles and responsibilities of various AMP entities and GCMRC are contained in the Ad Hoc Committee Roles Report (2006).

Lead Roles of GCMRC	**Lead Roles of AMP Managers/Stakeholders**
• Develop and revise the GCMRC SSP, MRP, and BAWP	• Develop, revise, and finalize the AMP Strategic Plan involving AMP goals and information needs, establish priorities, and management objectives
• Develop and update Knowledge Assessment and State of the Colorado River Ecosystem (SCORE) reports	• Develop and revise operations protocol to improve the effectiveness of the AMP

• Advise TWG/AMWG on technical program needs, experimental options, treatments	• Review and comment on the proposed science programs and budgets and provide recommendations to the Secretary
• Develop research designs and proposals and treatment options; Implement and manage the science program	• Provide clear and timely management direction
• Evaluate the scientific basis of proposed management actions/treatment programs	• Identify and implement management actions/treatments programs

The success of the AMP is dependent not only on the GCMRC's ability to produce scientific information that is relevant to management needs, but also upon effective and timely utilization of that information by managers in the decision making process. The challenge for scientists is to synthesize large amounts of diverse and often highly technical data into a form that is relevant to a decision (such as how to operate GCD) that has implications for multiple resources in different areas and timeframes. Over the past decade, there have been great advances in the development and application of a suite of decision support tools to assist scientists and managers in understanding the interrelationships, data uncertainty, and relative influence of scientific knowledge on resource management decisions.

The GCMRC proposes a collaborative strategy among scientists and AMP participants to develop and facilitate an independent assessment of how to better integrate the use of scientific information into the AMP process. The assessment will address (a) the feasibility of developing/utilizing decision support tools to facilitate integration of scientific information in the science planning and AMP recommendation processes including resource tradeoff assessments, and (b) strategies/approaches for more effectively addressing the value based conflicts reflected by the diverse interests in the AMP. Pilot approaches developed through this process will be implemented and tested over the 2007-2011 program period.

Strategic Science Questions to Address Priority AMWG Goals/Questions

The GCMRC science program will be driven primarily by AMWG Priority Questions and the associated key Strategic Science Questions as identified through the "Knowledge Assessment of the Effects of GCD on the Colorado River Ecosystem" (Melis and others, 2006). Addressing the key Strategic Science Questions presented below will result in information directly related to AMWG priorities and reduce the uncertainties associated with various flow and non-flow treatments being considered by the AMP.

The Strategic Science Questions will be addressed through core monitoring, experimental research, and research and development programs using an interdisciplinary/integrate science approach where appropriate. Specific monitoring and research projects will be

defined in the MRP and BAWP, based on the Knowledge Assessment, the Core Monitoring Information Needs (CMIN), Research Information Needs (RIN), and other relevant information. The MRP/BAWP will identify the project scope, objectives, methods, outcomes, and costs by fiscal year.

GCMRC will coordinate/collaborate with other relevant research activities being conducted by agencies and institutions to ensure a more coordinated and/or cost effective ecosystem approach.

AMWG Priority 1: Why are the humpback chub not thriving, and what can we do about it? How many humpback chub are there and how are they doing? (AMP Goal 2)

Key Strategic Science Questions

1. To what extent are adult populations of native fish controlled by production of young fish from tributaries, spawning and incubation in the main stem, survival of young-of-year (YoY) and juvenile stages in the main stem, or by changes in growth and maturation in the adult population as influenced by main stem conditions? [FY06-11]

2. Does a decrease in the abundance of rainbow trout and other cold and warm water non-natives in Marble and eastern Grand Canyons result in an improvement in the recruitment rate of juvenile humpback chub to the adult population? [FY06-11]

3. Do rainbow trout immigrate from Glen to Marble and eastern Grand Canyons, and, if so, during what life stages? To what extent do Glen Canyon immigrants support the population in Marble and eastern Grand Canyons? [FY07-11]

4. Can long-term decreases in abundance rainbow trout in Marble and eastern Grand Canyons be sustained with a reduced level of effort of mechanical removal or will re-colonization from tributaries and from downstream and upstream of the removal reach require that mechanical removal be an ongoing management action? This question also applies to future removal programs targeting other non-native species. [FY07-11]

5. What are the important pathways, and the rate of flux among them, that link lower trophic levels with fish and how will they link to dam operations? [FY06-09]

6. Are trends in the abundance of fish populations, or indicators from fish such as growth, condition, and body composition (e.g., lipids), correlated with patterns in invertebrate flux? [FY06-09].

7. Which tributary and mainstem habitats are most important to native fishes and how can these habitats best be made useable and maintained? [FY 08-09].

8. How can native and non-native fishes best be monitored while minimizing impacts from capture and handling or sampling? [FY07-11].

AMWG Priority 2: Which cultural resources, including Traditional Cultural Properties (TCP), are within the Area of Potential Effect, which should we treat, and how do we best protect them? What is the status and trends of cultural resources and what are the agents of deterioration? (AMP Goal 11).

Key Strategic Science Questions

1. Do dam controlled flows affect (increase or decrease) rates of erosion and vegetation growth at archeological sites and TCP sites, and if so, how? [FY07-11]

2. How do flows impact Old High Water Zone terraces in the CRE (where the majority of archaeological sites occur), and what kinds of important information about the historical ecology and human history of the CRE are being lost due to ongoing erosion of the Holocene sedimentary deposits? [FY04-11]

3. If dam controlled flows are contributing to (influencing rates of) archeological site/TCP erosion, what are the optimal flows for minimizing future impacts to historic properties? [FY09-11]

4. How effective are various treatments (e.g., check dams, vegetation management, etc.) in slowing rates of erosion at archaeological sites over the long term? [FY06-11]

5. What are the TCPs in the CRE, and where are they located? [FY06-11]

6. How can tribal values/data/analyses be appropriately incorporated into a science-driven adaptive management process in order to evaluate the effects of flow operations and management actions on TCPs? [FY06-08]

7. Are dam controlled flows affecting TCPs and other tribally-valued resources in the CRE, and, if so, in what respects are they being affected, and are those effects considered positive or negative by the tribes who value these resources? [FY06-11]

AMWG Priority 3: What is the best flow regime? (AMP Goals 1-11)

Key Strategic Science Questions

1. Is there a “Flow-Only” operation (i.e. a strategy for dam releases, including managing tributary inputs with BHBFs, without sediment augmentation) that will restore and maintain sandbar habitats over decadal time scales? [FY08-11]

2. To what extent could predation impacts by non-native fish be mitigated by higher turbidities or dam controlled high flow releases? [FY07-08]

3. What are the hydropower replacements costs of the Modified Low Fluctuating Flow (MLFF) (annually, since 1996)? [FY07-08]

4. What are the projected hydropower costs associated with the various alternative flow regimes being discussed for future experimental science (as defined in the next phase experimental design)? [FY06-07]

5. How is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations? [FY06-08]

6. What GCD operations (ramping rates, daily flow range, etc.) maximize trout fishing opportunities and catchability? [FY07-08]

7. How do dam controlled flows affect visitors' recreational experiences, and what is/are the optimal flows for maintaining a high quality recreational experience in the CRE? [FY07-08]

8. What are the drivers for recreational experiences in the CRE, and how important are flows relative to other drivers in shaping recreational experience outcomes? [FY07-09]

9. How do varying flows positively or negatively affect campsite attributes that are important to visitor experience? [FY09-11]

10. How can safety and navigability be reliably measured relative to flows? [FY07-08]

11. How do varying flows positively or negatively affect visitor safety, health, and navigability of the rapids? [FY07-09]

12. How do varying flows regimes positively or negatively affect group encounter rates, campsite competition, and other social parameters that are known to be important variables of visitor experience? [FY07-09]

AMWG Priority 4: What is the impact of sediment loss and what should we do about it? (AMP Goal 8)

<u>Key Strategic Science Questions</u>

1. Is there a "Flow-Only" operation (i.e. a strategy for dam releases, including managing tributary inputs with BHBFs, without sediment augmentation) that will restore and maintain sandbar habitats over decadal time scales? (FY 08-11)

2. How important are backwaters and vegetated shoreline habitats to the overall growth and survival of YoY and juvenile native fish? Does the long-term benefit of

increasing these habitats outweigh short-term potential costs (displacement and possibly mortality of young humpback chub) associated with high flows? [FY07-11]

AMWG Priority 5: What will happen when we test or implement the Temperature Control Device (TCD)? How should it be operated? Are safeguards needed for management? (AMP Goals 1-4 and 7-10)

Strategic Science Questions

1. How do dam release temperatures, flows (average and fluctuating component), meteorology, canyon orientation and geometry, and reach morphology interact to determine mainstem and near shore water temperatures throughout the CRE? [FY06-08]

2. How is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations? [FY06-08]

3. To what extent do temperature and fluctuations in flow limit spawning and incubation success for native fish? [FY03-08]

4. What is the relative importance of increased water temperature, shoreline stability, and food availability on the survival and growth of YoY and juvenile native fish? [FY03-08]

5. Will increased water temperatures increase the incidence of Asian Tapeworm in humpback chub or the magnitude of infestation, and if so, what is the impact on survival and growth rates? [FY03-08]

6. Do the potential benefits of improved rearing habitat (warmer, more stable, more backwater and vegetated shorelines, more food) outweigh negative impacts due to increases in non-native fish abundance? [FY07-11]

7. How do warmer releases affect viability and productivity of native/non-native vegetation? [FY07-11]

Critical research and monitoring needs outside the scope of the AMP

This element focuses on a critical need in the AMP to address issues outside the CRE that impact the AMP mission and goals. Scientists and managers are currently constrained from evaluating some potentially significant external threats to CRE resources. For example, the largest aggregation of HBC in the CRE is directly dependent on water quality from the Little Colorado River (LCR). However, water quality is evaluated on an infrequent basis and then only in the first few miles of its confluence with the Colorado River. No science activity currently exists to identify changes in LCR water quality and

quantity resulting from upstream diversions, pollution and/or catastrophic hazardous material spill. Second, the primary determinant of water quality in the CRE is the water released from Lake Powell. The water quality characteristics and dynamics of Lake Powell have major implications for the design and operation of Reclamation's proposed Selective Withdrawal Structure (SWS) that will allow for regulating the temperature and other water quality characteristics of releases from Glen Canyon Dam. While extensive physical and biological data on Lake Powell water quality have been collected for over two decades, the data have not been synthesized or subjected to extensive analysis or advanced modeling. A synthesis of historical Lake Powell data is needed to identify trends in water quality and its relationship to link dam operations, basin hydrology, and climate variability. These assessments could significantly advance knowledge of potential future water quality in Lake Powell and the appropriate design and operation of the SWS.

To be successful, the AMP needs to ensure that key external factors that could affect the attainment of AMP goals are addressed. The GCMRC proposes to (a) work closely with the AMWG and Department of the Interior to help develop an endangered fish recovery program for the lower basin/Grand Canyon, (b) evaluate and report on the above key external issues that could affect attainment of AMP goals, and (c) work with AMP and other relevant parties to secure funding to initiate science programs to address key issues that pose the highest risk or opportunity.

GCMRC ADMINISTRATION AND BUDGET

GCMRC Administration and Staffing

The GCMRC's goal is to deliver a comprehensive ecosystem science program over the next 5 years that is effective in responding to management needs. Effectiveness will be measured by science and management accomplishments that enhance CRE resource conditions and a better understanding of the cause-effect relationship between dam operations and resource conditions. The importance of gaining improvements in science administration increases as flat budgets are provide to meet growing needs for a broader, more comprehensive ecosystem science program.

Strategies for improved administration require significant accomplishment in several areas including more effective science planning, effective personnel structure, focused goals and objectives, extensive collaboration and partnerships, and cost effective research designs focused on priority information needs.

Productive, well qualified personnel are critical to meeting this strategy. Efforts have been extended to restructure personnel responsibilities at GCMRC to maximize application of existing management and science skills. Contractors and cooperators will be utilized to conduct a large measure of the field work and work collaboratively with GCMRC on data analysis, synthesis, and publication. GCMRC scientists will be engaged

in the implementation of field research and monitoring when in-house staff with the appropriate expertise is available and their use is cost effective. In every case the USGS will hold its own proposals to the same level of rigorous outside peer review as all others.

The core GCMRC staff includes the following key positions:

- **Center Chief**: Establishes Center science policies and strategic direction and provides accountability for the GCMRC budget. Assures that science managers, contract and budget officers, logistics specialists, external and resident scientists, etc., plan and implement timely science programs that respond to managers' priority information needs. Interfaces with USGS management, Secretary's AMP Designee, and AMP managers to assure that quality science is provided in a timely manner on priority issues identified by the AMP leadership.

- **Deputy Chief**: Responsible for day-to-day management and supervision of the Science Program and assuring that integrated ecosystem science methods and procedures are utilized in science design and analysis. Monitors, through accepted review procedures, peer review processes, science project performance and reporting to assure timely responses to managers' information needs.

- **Program Managers**: Responsible for the timely execution of the science program within their program area; interaction with other program areas to ensure integrated ecosystem approaches, quality control of products and contractors/ cooperators; contract/agreement management; management of budget within their program area, and providing reports to AMP work groups as needed. GCMRC activities now encompass five major program areas:

    - The **Physical Science and Modeling Program** conducts research and monitoring activities on physical elements of the Colorado River Ecosystem including studies of sediment storage and transport in the regulated river, integrated downstream water quality monitoring and research. The Program has been responsible for conducting several experimental high flow releases from GCD to conserve sediment resources for building beaches and improving habitat for native aquatic species in the Colorado River. More recent tasks have included refinement of a downstream temperature model for the ecosystem

    - The **Data Acquisition, Storage, and Analysis Program** that provides GIS, data quality control and data management support to all Program areas

    - The **Biological Program** that provides scientific information that supports the conservation of native species in the Grand Canyon and the Lees Ferry trout fishery. Elements of the program include the assessing the effects of GCD on fishery resources, characterizing the aquatic food base, improving fish community monitoring, developing and testing of techniques to control non-

native fishes, and water quality monitoring and modeling in Lake Powell and the Colorado River below GCD

- The **Cultural and Socio-Economic Program** that focuses on cultural resources and recreation activities based in the Grand Canyon. The current focus is on development of comprehensive monitoring programs to assess the condition of the archeological sites affected by the operation of GCD

- The **Logistics Program** that supports up to 40 river trips per year and coordinates research permit management for the Center. The Logistics Program also provides survey support to various program and activities

The GCMRC will rely on the Southwest Biological Science Center (SBSC), the parent organization of GCMRC, for administrative/budget/contracting, information/ technology, and policy support. The GCMRC will also work with SBSC to reduce shared costs and overhead burden assessed by USGS on AMP funds.

As part of this strategy to improve science administration effectiveness, the Center Chief will collaborate with the Department of the Interior, Department of Energy, and the AMWG/TWG to:

Assure that AMP Strategic Plan direction is kept current to include most recent revisions of on priority goals, information needs, and desired future resource conditions;
Design a partnership plan and program to transition major science treatments into management actions with appropriate responsibilities, authorities, and funding;

- Develop greater interaction among the Upper Colorado River Recovery Implementation Program, and Lower Colorado River Multi-species Conservation Plan to share science findings, methods, management actions, etc.; and

- Create approaches to resolve budget limitations of the AMP regarding increasing science and management needs

GCMRC Budget

A general assessment of the GCMRC's budget needs over the period FY 2007-2011 indicates that the planned science programs could be accomplished with moderate increases in budget allocations. To do so will require effective management of priorities, termination of selected programs, and extend implementation over time of lower priority goals and information needs. Implementation of experimental research programs will require careful planning to avoid major disruptions to planned and ongoing activities.

The following selected budget management strategies will be pursued by GCMRC to obviate the impacts of unpredictable events to the program over the next 5-10 year period:

- Develop and approve annually detailed 2-year AMP budgets and projects in the Biennial Work Plan;
- Develop protocols for establishing a contingency fund sufficient to support anticipated future experimental projects;
- Conserve a percentage of overall funds for reallocating at the discretion of the Chief when savings or shortfalls occur in specific areas;
- Develop protocols for guiding external budget development by the GCMRC to respond to issues affecting the AMP, but currently outside the AMP budget process; and
- Seek additional congressional funding to support research to address (a) testing/operation of a Selective Withdraw Structure and other large capital projects and (b) external factors or issues outside the scope of the AMP that impact AMP goals.

LITERATURE CITED

Gloss, S.P., Lovich, J.E., and Melis, T.S., eds., 2005. The State of the Colorado River Ecosystem in Grand Canyon: A Report of the Grand Canyon Monitoring and Research Center 1991-2004: U.S. Geological Survey Circular 1282, 220 p.

Holling, C.S., 1978, Adaptive Environmental Assessment and Management: Chichester, New York, Wiley, 785 p.

Melis, T.S., Wright, S.A., Ralston, B., Fairley, H., Kennedy, T., Coggins, L., and Korman, J., authors, 2006. Knowledge Assessment of the Effects of Glen Canyon Dam on the Colorado River Ecosystem, 77 p.

Walters, C.J., 1986, Adaptive Management of Renewable Resources: New York: Macmillan, 374 p.