

## MANAGEMENT OBJECTIVES

- The Resource Goal may be a pre-dam goal, but we are working within the capabilities of the post-dam management. Constraints imposed by the Preferred Alternative and the ROD.
- Objectives will look at capabilities of post-dam resource constraints.

**DRAFT**  
**GLEN CANYON DAM MANAGEMENT OBJECTIVES**  
March 16, 1998

**PURPOSE**

The purpose of the for developing management objectives is to define measurable standards of desired future resource conditions which will serve as targets objectives expected to be achieved by the participants all stakeholders in the Glen Canyon Dam Adaptive Management EIS process. These expectations objectives are framed within the Preferred Alternative and implemented by specific dam operating criteria and other actions taken by the Secretary. It is the purpose of this effort to monitor impacts of and/or change where necessary these specific operating criteria to achieve the overall goals of the EIS process.

Information Needs define the specific scientific understanding required to obtain specified management objectives.

Objectives and Information Needs specified by stakeholders are the basis for development and implementation of annual monitoring and research programs. Research plans are developed annually and must address specified stakeholder information needs.

**BACKGROUND**

The Operation of Glen Canyon Dam Final Environmental Impact Statement states that an Adaptive Management Program (AMP) will be initiated following the issuance of a Record of Decision by the Secretary of the Interior. The concept of adaptive management is based on the recognized need for operational flexibility to respond to future monitoring and research findings and varying resource conditions. The purpose of the AMP will be to develop modifications to the Glen Canyon Dam Operations and to exercise other authorities under existing laws to protect, mitigate adverse impacts to, and improve the values for which the Glen Canyon National Recreation Area and Grand Canyon National Park were established. The AMP will monitor the results effect of the operating criteria adopted by the Secretary as a result of the EIS process and develop proposed changes to those criteria and propose other actions as necessary to achieve the results anticipated in the EIS Preferred Alternative of the Environmental Impact Statement and the Record of Decision.

Principals which guided the design of the AMP include:

- Monitoring and research programs should be designed by qualified researchers in direct response to the objectives and information needs of AMWG members, management agencies.
- A process is required to coordinate and communicate AMWG management agency

information needs to researchers and to develop recommendations for decision making.

The Transition Adaptive Management Work Group recognized the desirability of beginning the process of clarifying and consolidating the management objectives of organizations agencies that will be participating in the AMP in order to clearly identify management needs to the researchers. Initiating this process will facilitates and expedites monitoring and research designs. when the AMP is formally initiated. A Management Objectives Subgroup was formed to develop draft objectives, herein defined as Resource Management Targets Objectives, for this purpose.

## **PROCESS**

The procedure selected for development and approval of Stakeholder Objectives and Information Needs is as follows:

**Defining Goals, Objectives and Information Needs.** Defining terms were developed by Stakeholders as a guide to articulation of Goals, Objectives, Information Needs and Management Actions as follows:

<b><u>TERM</u></b>	<b><u>DESCRIPTORS</u></b>
<b>Goals</b>	<ul style="list-style-type: none"> <li>- Directional Statement</li> <li>- Qualitative</li> <li>- Rarely Attained</li> <li>- Generic</li> </ul>
<b>Objectives</b>	<ul style="list-style-type: none"> <li>- Defines desired Future Resource Condition</li> <li>- Quantifiable</li> <li>- Has Target Dates</li> <li>- Has Timelines</li> <li>- Concise</li> <li>- Within Legal Boundaries</li> </ul>
<b>Information Needs</b>	<ul style="list-style-type: none"> <li>- Uses Information Collection Process</li> <li>- Results in Product, Outcome, Report, Model, Data</li> <li>- Incorporates Data Collection, Analysis, Synthesis, etc.</li> <li>- Accomplishment associated with Management Objective</li> </ul>
<b>Management Actions</b>	<ul style="list-style-type: none"> <li>- A Management Activity</li> <li>- Has Timeline</li> <li>- Has Target Date</li> <li>- Concise</li> <li>- Within Legal Boundary</li> </ul>

**Development of Objectives, Information Needs and Management Actions.** (Palmer comment 3-12-98): The Management Objectives are initially designed to be in accord with the EIS; these objectives do not define the ideal desired future resource condition. Rather, they describe, clarify and detail the resource impacts described in the EIS for the preferred alternative. Under the operating criteria signed by the Secretary, the GCMRC will monitor the resources and periodically inform the TWG and AMWG regarding the condition of the resources. If the operation of Glen Canyon Dam under the criteria fail to meet these objectives the AMWG will either recommend operational changes to the Secretary or modify the management objectives. Initial development of Objectives, Information Needs and Management Actions can and usually occur by individual stakeholders. However, discussion and agreement on Management Objectives, Information Needs, and Management Actions to be included in the Adaptive Management Program must occur in an open forum of the Technical Work Group (TWG). Final approval of Management Objectives, Information Needs and Management Actions to be used in developing Grand Canyon Monitoring and Research Center (GCMRC) monitoring and research plans is by the Adaptive Management Work Group (AMWG).

The following draft Management Objectives, Information Needs and Management Actions are still in development and will not be approved by the TWG or AMWG until July, 1998. They are being designed to guide GCMRC program planning through the period FY1999-2003.

## CULTURAL RESOURCES

**Goal:** To preserve *in situ*, and develop where appropriate, knowledge of the resource that can be maintained for future generations.

**Definition:** Cultural resources include prehistoric and historic archaeological sites, structures and properties of interest to all Americans. Of particular importance are traditional cultural properties, sacred sites, collection areas, and other resources that are important to Native Americans in maintaining their cultural heritage, lifeways, and practices. Cultural resources are nonrenewable and irretrievable if lost.

**Examples:** — Prehistoric/historic, archaeological, traditional, cultural properties sites, sacred sites, collection areas

## MANAGEMENT OBJECTIVES, STAKEHOLDER INFORMATION NEEDS, MANAGEMENT ACTIONS

### MO 1

Conserve *in situ* all the downstream cultural resources to take into account Native American cultural resource concerns in Glen and Grand Canyons the Colorado River ecosystem. ~~riverine corridor.~~

- SIN 1.1: Develop data and monitoring systems to assess:
  - SIN 1.1a Types of degradation, threats
  - SIN 1.1b Rates of degradation
  - SIN 1.1c Define immediacy of threats to resources
  - SIN 1.1d Protection methodologies
  - SIN 1.1e Protection, monitoring and research costs

### MO 1.1

If *in situ* conservation is not possible, design mitigative strategies that integrate the full consideration of the values of all concerned tribes with a scientific approach.

- SIN 1.1 Characterize through scientific study and data development all assumed historical and current values of resources to tribal nations and to general public
- SIN 1.2 Develop data systems to assess variable risk of damage/loss of differing resources/sites from preferred and alternative strategies and operating criteria
- SIN 1.3 Develop mitigative costs

**MO 2**

Protect, and maintain physical access to and use of traditional cultural properties and other cultural resources, where such access and use may be impacted by dam operations.

- SIN 2.1 Characterize historic and current religious associations of all sites associated with impacts of dam operating criteria

**MO 3**

Maintain and integrate all cultural data recovered from monitoring, remedial, and mitigative action and incorporate these data into the evolving research designs for understanding the human occupation and use of the Grand Canyon.

- SIN 3.1 Characterize all cultural resource sites as to the specific associated management/research needs, i.e.; preservation, stabilization, documentation, etc.; under alternative operating criteria
- SIN 3.2 Preservation, stabilization and/or documentation of cultural resources as impacted by sediment resources associated with alternative operating criteria
- SIN 3.3 Preservation, stabilization of flood terraces holding cultural resources
- SIN 3.4 Evaluate flood terrace stability necessary to maintain cultural resources and terraces at pre-dam conditions

## HYDROPOWER

**Goal:** To maximize the value of long term firm power and energy generation within the criteria and operating plans established by the Secretary under Section 1804 of the Grand Canyon Protection Act.

**Definition:** A secondary product and service of Glen Canyon Dam is electrical generation. The facility contributes significant power to the southwestern United States. (C. Palmer comment dated 3-12-98): A product of the Glen Canyon Power plant is electrical generation. The facility contributes significant power to rural electrical associations, public municipalities, irrigation districts and Federal and State facilities in the Southwestern and Rocky Mountain areas of the United States.

**Examples:** ~~Peaking power capabilities; Base power capabilities~~

### MANAGEMENT OBJECTIVES, STAKEHOLDER INFORMATION NEEDS, MANAGEMENT ACTIONS

#### MO 1

Maximize the value of long-term power and energy generation within the criteria and operating plans established by the Secretary under Section 1804 of the Grand Canyon Protection Act.

#### **Information Needs:**

**SIN 1.1** (Comment from Cliff Barrett 3/10/98): The data needed to measure and evaluate power production is already routinely collected by the USBR and WAPA (no data gathering is required of GCMRC).

**SIN 1.2** (SIN 1.2-1.4 are comments from Clayton Palmer 3/12/98): Continue to monitor the amount of revenues collected from the generation of electrical power at the Glen Canyon Power plant.

**SIN 1.3** Continue to account for the financial cost of the operational changes at Glen Canyon Dam due to the ROD including rate impacts to CRSP long-term firm electrical customers.

**SIN 1.4** Calculate the financial costs of research flows so that these costs can be declared \*non-reimbursable\* and be credited against Western's repayment obligations.

**SIN 1.5** **Monitor any difficulties in operating an integrated electrical system, including regulating a load control area.**

## NATIVE TERRESTRIAL WILDLIFE RESOURCES

**Goal:** To maintain a diversity of wildlife species associated with ongoing natural evolutionary and ecological processes giving priority to native species (i.e., those occurring not directly because of man).

**Definition:** Native wildlife resources include bats, sheep, and riparian birds.

- Protect, restore, and enhance survival of special status species (Federal, tribal, and state designations). Ensure that the required habitat for these species is preserved.

**Examples:** Native wildlife resources; bats, sheep, riparian birds

## MANAGEMENT OBJECTIVES, STAKEHOLDER INFORMATION NEEDS, MANAGEMENT ACTIONS

### MO 1

Protect, restore, and enhance survival of native and special status species (federal, tribal, and state designations). Ensure that the required habitat for these species is preserved. Maintain native faunal components of the ecosystems for the benefit of beneficial to threatened and endangered species.

- SIN 1.1 Evaluate the viability of food chain(s) for native fauna, including the Peregrine Falcon, Southwestern Willow Flycatcher, and other special status species.
- SIN 1.2 Monitor peregrine falcon breeding sites in Glen Canyon and Grand Canyon. (CR 2)
- SIN 1.3 Study peregrine falcon population dynamics and determine their relationship to the changing riparian ecosystem for meeting life stage requirements (CR 3)
- SIN 1.4 Continue monitoring of eagle habitat utilization and foraging patterns and their relationship to dam operations and perform additional eagle monitoring where deemed feasible (CR 4)

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### Original Information Needs for MO 1:

1. Define and specify ecology of native faunal components, especially threatened and endangered species; including evolutionary and environmental changes, natural range of variation, linkages, interdependencies, and requirements
2. Monitor species population to detect departures from natural range of variation

**3. Monitoring changes, declines in special status species and characterize ecosystem changes to benefit species**

*Original Information Needs for MO 3 which was moved to MO 1:*

*1. Define food chain associations, interdependencies, requirements, etc., for native species population targets.*

*2. Monitor impacts of alternative operating criteria on food chain associations.*

**MO 2**

Maintain a natural age-class distribution throughout the majority of natural range in Glen and Grand Canyons, emphasizing the need to recruit into breeding age classes.

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Original Information Needs for MO 2:

1. **Determine species' natural ranges (pre and post dam)**
2. **Determine historic age class distribution (pre and post dam)**
3. **Assess natural range and age class disruption, changes, constraints, probable long-term viability implications to species; assess alternate habitat, ecology associations (specifically age class); and ecosystem associations**
4. **Monitor impacts of alternative operating criteria on ecosystem and ecology requirements of species**

*Management Objective #3: (Identified as Info Need under MO #1 - moved.)*

~~*Management Objective #4: Inasmuch as such management is not deleterious to naturally occurring ecosystem components, consider and mitigate impacts to special status species that may use the river corridor opportunistically (Bald Eagle). Maintain self-sustaining fish populations as forage to provide opportunities for bald eagles. Monitor for nesting.*~~

~~*Management Objective #5: The population of Kanab Ambersnail should be inventoried and maintained near current levels. Efforts to establish additional population center should be guided by the recovery plan for the species.*~~

**MO 5.3**

Attain the Reasonable and Prudent Alternatives for sustainable populations of Kanab Ambersnail established by the U.S. Fish and Wildlife Service.

- SIN 3.1** Determine specific habitat characteristics required by the KAS (T&C 3--p.41)
- SIN 3.2** Conduct studies to determine special flow impacts on Kanab ambersnail to assure that the level of incidental take is not exceeded. (Incidental Take--p.40)
- SIN 3.3** Complete a census of the population and characterize the habitat. Once habitat requirements are determined, other potential habitat sites within the Grand Canyon corridor will be surveyed to determine species presence and recovery potential. (CR.5--p.43)
- SIN 3.4** Survey KAS habitat before and after any flow greater than 25,000 cfs to determine the species response to disturbance and ability to recover (T&C 4--p.42)
- SIN 3.5** Determine Kanab Ambersnail life history schedule for populations in the Colorado River ecosystem. (RPA C.v.--p.37)
- MA 3.1** Protect the habitat necessary for the survival of the existing population of Kanab ambersnail. (Incidental Take--p.40)
- MA 3.2** Do not allow high flows, or a controlled flood, to destroy more than 10% of the existing KAS occupied habitat in Grand Canyon. (Incidental Take--p.40)
- MA 3.3** Develop agreed upon research protocol and conduct research in such a manner as to minimize disturbance to the KAS population and habitat. (T&C 3--p.41) (Note: Tony Morton suggests that this be moved to Info Needs - SIN 3.6)
- MA 3.4** Conduct a thorough investigation into KAS life cycle processes and requirements to determine their relationship to the riparian ecosystem and their susceptibility and response to disturbance. (CR 5--p.43) (Note: Tony Morton suggests that this be moved to Info Needs - SIN 3.7)
- MA 3.5** Before another BHBf (45,000 cfs or greater), Reclamation will enter into informal consultation with the U.S. Fish and Wildlife Service and Arizona Game and Fish Department to:
- MA 3.5a** evaluate the test flow studies;

MA 3.5b evaluate the establishment or discovery of a second population of Kanab ambersnail in Arizona;

MA 3.5c evaluate incidental take.

MA 3.6 Survey Kanab Ambersnail habitat before and after any flow greater than 25,000 cfs to determine the species' response to disturbance and ability to recover. (T&C 4-- p.42)

MA 3.7 Continue coordination with the Interagency Kanab Ambersnail Working Group to establish or discover a second population of the Kanab ambersnail in Arizona. (Fall 97 Flow T&C 4)

\*\*MA 3.8 Monitoring of the project area and other areas that could be affected by the proposed action shall be done to ascertain take of individuals of the species and/or of its habitat that causes harm, harassment, or death to the species. This monitoring will be accomplished using the following protocol:

MA 3.8.1a "A Draft Proposal to Assess, Mitigate and Monitor the impacts of an Experimental High Flow from Glen Canyon Dam on the Endangered Kanab Ambersnail at Vaseys Paradise, Grand Canyon, Arizona" (Stevens *et al.* 1995b).

MA 3.8.1b In order to more accurately determine elevation of river stage at the range of flow that will be experienced during the test flow, and for use in developing a stage discharge relationship for future flow, the placement of a stage recorder, such as a pressure transducer coupled to a recorder should be deployed, if possible, in the mainstem at an appropriate site near the Kanab ambersnail population. The U.S. Geologic Survey should be contacted regarding the possibility of changing the location of a stage recorder to be used in test flow studies to the Kanab ambersnail site.

MA 3.8.1c SALVAGE PROTOCOL: Kanab ambersnail specimens found dead, or taken as part of research activities, shall be collected and held as specified in the AGFD permit, with final deposition in a suitable museum collection such as at Northern Arizona University (1996 BHBFB KAS T&C 1)

\*\*Needs to be investigated

**Original Information Needs:** *(these were associated with MO #5 on original MO/IN document, pg. 10; renumbered to MO #3 after 2-25-98 meeting - due to deletions of MOs 3&4)*

1. **Characterize historical and current populations of Kanab Ambersnail and their locations** *(Note: Tony Morton suggests that this old Info Need be deleted because it is now addressed through SIN 3.3, SIN 3.5 and MA 3.1, MA 3.4)*
2. **Determine ecology and ecosystem related requirements for Kanab Ambersnail to enhance 1996 levels** *(Note: Tony Morton suggests that this old Info Need be deleted because it is now addressed through SIN 3.3 and MA 3.5, MA 3.5b)*
3. **Monitor changes in populations, health, and character of Ambersnail**

### **MO 3.1**

Ensure the existence of a second population of Kanab Ambersnail in Arizona

**SIN 3.1.1** Investigate the transplant success of vegetation important to the Kanab ambersnail.

**SIN 3.1.1a** Investigate success of temporarily removing *Mimulus*, *Nasturtium*, or other appropriate vegetation into a temporary holding facility, and replanting. (1996 BHBFCM 5a)

**SIN 3.1.1b** Investigate success of temporarily/permanently relocating *Mimulus*, *Nasturtium*, or other appropriate vegetation. (1996 BHBFCM 5b)

**MA 3.1.1** Minimize future take and support salvage and refugia population(s) of KAS (Fall 97 Test Flow CM 1)

**MA 3.1.2** Provide logistical support to the Arizona Game and Fish Department's proposal to establish vegetation for the refugium population of the Kanab ambersnail at the Phoenix Zoo, and subsequent support for the transfer of ambersnails when permit and weather conditions permit. (Fall 97 Flow T&C 2)

**Management Objective #6:** ~~Maintain and enhance the aquatic food base in Glen Canyon. Maintain continuously inundated areas for Cladophora and aquatic invertebrates at or above 5,000 cfs discharge. (MO #6 was deleted, so Original Info Needs were deleted.)~~

**\*MO #7: 4**

Manage and maintain aquatic and riparian habitat to preserve a diverse mosaic of physical and biological characteristics to ensure that viable populations of resident and migratory wildlife continue to exist and flourish.

*(MO #7 was new, so no original info needs were associated; no new info needs on 2-25-98.)*

**\*GCMRC will evaluate for the stakeholders the specific objectives and recommend some science and/or other direction.**

## WATER RESOURCES

**Goal:** To operate Glen Canyon Dam for water flows and water quality consistent with existing law and policy.

**Definition:** Water resources include all aspects of water quantity and quality. Specific legislation and agency, tribal and interest group agreements guide water allocation through Glen Canyon Dam. Although of more recent concern, water quality as it relates to changes over time is of specific concern.

**Examples:** High quality water; Water quantities; Sediment

## MANAGEMENT OBJECTIVES, STAKEHOLDER INFORMATION NEEDS, MANAGEMENT ACTIONS

### MO 1

The Secretary shall Operate Glen Canyon Dam in a manner fully consistent with the preferred alternative Record of Decision and subject to the "Law of the River," including but not limited to the following: Grand Canyon Protection Act of 1992, the Colorado River Compact, the Upper Colorado River Basin Compact, the Water Treaty of 1944 with Mexico, the decree of the Supreme Court in Arizona vs. California, and the provisions of the Colorado River Storage Project Act of 1956, and the Colorado River Basin Project Act of 1968 that govern allocation, appropriation, development, and exportation of the waters of the Colorado River Basin.

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Original Info Needs:

#### 1. No information needs specified

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### MO 2

Maintain water quality at levels appropriate to support physical, biotic, and human resource needs of various ecosystems downstream of Glen Canyon Dam as mandated by the Grand Canyon Protection Act and incorporated into the Record of Decision.

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Original Information Needs:

1. Monitor water quality changes with time
  2. Monitor water quality as compared to state and federal standards
  3. Measure water composition and temperature and their changes over time
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## SEDIMENT RESOURCES

The overall resource management target objective Goal is To maintain a range of sediment deposits over the long-term, including an annually flooded bare-sediment (unvegetated) active zone, a less frequently flooded vegetated zone, terraces (within the 45,000 cfs river stage), and backwater channels. The goal of Managing sediment resources will be on a reach-scale basis. Should significant and localized adverse impacts occur, site-specific mitigation would be considered, along with possible modifications to dam operations.

**Definition:** Sediment resources include a broad array of material, ranging from suspended fines to coarse gravels. Primary interest relates to both material in suspension, which affects benthic capability, as well as stored sediment in beaches and channel margins, which affects recreation.

**Examples:** Flora and fauna habitat; Beaches for recreation and visual values; Nutrient transport

## MANAGEMENT OBJECTIVES, STAKEHOLDER INFORMATION NEEDS, MANAGEMENT ACTIONS

### MO 1

Maintain a long-term balance of river-stored sand to support maintenance flow (in years of low reservoir storage), beach/habitat-building flow (in years of high reservoir storage), and unscheduled flood flows. Maintain system dynamics and disturbance by annually (in years which Lake Powell water storage is low) redistributing sand stored in the river channel and eddies to areas inundated by river flows between 20,000 cfs and 30,000 cfs maximum power plant capacity. *(Note: this was previously Objective #4)*

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Original IN's for this MO:

1. **Define historical and current (character and structure) levels of river stored sediment in system and associated flow regimes**
  2. **Define minimal levels of river stored sediments necessary to maintain long term sandbar, backwater, instream sediment deposits**
  3. **Develop procedures to monitor and predict impacts of alternative operating criteria (flow regimes) on river stored sediment, and impacts in select reaches**
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**MO 2**

As a minimum for each reach, maintain the number and average size (area and thickness) of sandbars and backwaters between the stages associated with flows of 8,000 and 45,000 cfs and the number and average size of backwaters at 8,000 cfs (*Note: strikeout was moved to Fish & Aquatic section*) that existed during the 1990/91 research flows.

*(Note: this was previously Objective #1)*

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**Original Information Needs for this MO:**

1. **Characterize sandbar/backwater baselines and character and structure in 1990/91**
  2. **Working with various resource agencies and specialists, select most appropriate flow levels/regimes to determine baseline for comparisons for all resources**
  3. **Monitor future changes in sediment and define balances (channel, banks, bars) and hydraulic processes necessary to maintain 1990-91 sandbar levels**
  4. **Evaluation of flow regime impacts on terrace and cultural resources**
  5. **Evaluate historical sandbar/backwater change, and develop methods for predefining beach and sandbar change under alternative operating criteria**
  6. **Determine implications of alternative dam operating criteria on beach and sandbar and backwater character and structure**
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**MO 3**

Periodically increase the average size of sandbars above the 20,000 cfs river stage and number and average size of backwaters at 8,000 cfs to the amounts measured after the 1996 test of the beach/habitat-building flow in as many years as reservoir and downstream conditions allow.

*(Note: previously Objective #2)*

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**Original IN's for this MO:**

1. **Define 1996 and 1990/91 backwater ecosystems and associated flow regimes**
2. **Define historical variation in backwater number and character**
3. **Define changes between 1990/91 and 1996 in sediment and backwater resources character and structure associated with dam operating criteria**

4. **Define all linkages, associations, interdependencies, etc.; of physical sediment resource and backwater resources to biotic entities**
  5. **Define processes necessary to maintain backwaters at 1990-1991 and 1996**
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#### **MO 4**

Maintain system dynamics and disturbance by redistributing sand stored in the river channel and eddies to areas inundated by river flows up to 45,000 cfs in as many years as possible when downstream resources warrant and when Lake Powell water storage is high. ~~The degree to which these targets are met can be monitored by measuring rates of sediment deposition and erosion, the area of bar sediment deposits, and the number and size (thickness and area) of sandbars of interest (such as camping beaches). (Note: this was previously Mgmt Objective #3)~~

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#### **Original IN's for this MO:**

1. **Define character and structure of all beaches and backwaters in system after 1996 test flows**
  2. **Develop methodologies to define future flow regimes to maximize benefit to sediment and backwater character and structure**
  3. **Develop an assessment of dam operation impacts on range of variation in sediment and other resources within riverine corridor and the associated processes that created these ranges**
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## FISH AND AQUATIC

The Goal is general targets objectives are to protect and enhance native fish populations in Glen and Grand Canyons, as well as recreationally-important cold water sportfish populations in Glen Canyon, and the aquatic foodbase upon which they depend.

**Definition:** Fish and Aquatic resources include both native and non-native species with specific concerns for Threatened and Endangered Species. Other aquatic species include salamanders, frogs, Cladophora, etc. Of specific concern are plant and animal matter contributing to the primary food base.

- *Maintain native fish populations at or above levels observed on average over the last ten years, measured on a rolling ten-year average.*

**Examples:** Native fishes; Non-native fishes; Aquatic flora

## MANAGEMENT OBJECTIVES, STAKEHOLDER INFORMATION NEEDS, MANAGEMENT ACTIONS

### Native Fishes:<sup>1</sup>

#### MO 1

**Maintain or Enhance** the existing population of humpback chub at or above 1987 levels determined by April/May hoop-net monitoring in the lower 1,200 meters of the Little Colorado River. (Focused at fish >200mm, and should include a fish health assessment.) Maintain levels of recruitment of humpback chub in the mainstem and Little Colorado River, as indexed by size frequency distributions and presence and strength of year-classes. (Focused at young-of-year and juvenile fish, and should include a fish health assessment.)

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#### **Original Information Needs Native Fish/MO #1 - Chubs:**

1. **Monitor adult humpback chub populations and evaluate population level trends**
2. **Monitor levels of recruitment of humpback chub in the mainstem and the LCR**
3. **Monitor quantity and quality of chub backwater and near shore habitat in mainstem**

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<sup>1</sup> Note that Critical Habitat has been designated in GC for both razorback sucker and humpback chub. As Critical Habitat for razorback sucker, GC may have a role in recovery as a reintroduction site. Such actions would need to be guided by the recovery plan (now in prep) or regional implementation plans.

4. Determine and identify surrogate native or non-native fishes for evaluation of health factors for humpback chub
5. Develop a backwater quality index, using existing data for humpback chub
6. Evaluate impacts of sampling methods and recreation use on native fish populations

### MO 2

Verify the status of and management for healthy, self-sustaining populations of flannelmouth sucker, bluehead sucker, and speckled dace in the mainstem Colorado River in Grand Canyon and its tributaries, and manage for healthy, self-sustaining populations. Verify the status of and management for healthy, self-sustaining populations of native fish in Glen Canyon, and manage for healthy, self-sustaining populations based upon the capability of the habitat to support those fishes. (Focused at young-of-year, juvenile, and adults to determine size frequency distributions, densities [via catch rates], and assessment of fish health.)

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#### Original Information Needs Native Fish MO #2:

1. Determine historic and current character and structure of species populations
2. Determine historic and current ecosystem requirements (habitat, spacing, food source, interdependencies, etc.) of species
3. Monitor and define impacts of alternative flow regimes on species population character and structure
4. Determine requirements to maintain/enhance self-sustaining populations of species

### MO 3

~~Establish a second spawning aggregation of humpback chub downstream of Glen Canyon Dam. (Tony Morton's #23, changed to MO 8.4. Delete MO #3 & replace.)~~

~~Establish a second, self-sustaining population of humpback chub by 2005, contingent on feasibility. Monitor for spawning and determine the contribution of other existing aggregations as one component of assessing feasibility.~~

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#### Original IN's for this MO:

1. **Develop criteria for self sustaining populations of humpback chub**
  2. **Assess feasibility of second population including other current aggregations**
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#### **MO 4**

**As a minimum for each reach, maintain the number and average size of backwater at 8,000 cfs. Maintain sufficient rearing habitat for native fish to complete critical life stages.**

*(Note: This MO was moved from Sediment. First it was MO #1, then changed to MO #2 under Sediment. Group to review which info needs pertain to backwaters/native fish)*

#### **MO 5**

**Recommend actions to further conservation of listed and native fish fauna.**

#### **Trout**

##### **MO 6 5**

**In the Colorado River downstream of Glen Canyon Dam to the confluence of the Paria river, sufficient suitable habitat (ecological conditions (such as habitat, foodbase and temperature) should be maintained, which in conjunction with management of Arizona Game and Fish will produce a self-sustaining population of up to 100,000 or greater Age II+ rainbow trout.**

**In the Colorado River corridor below Glen Canyon Dam to the confluence with the Paria River, natural reproduced fish should compose at least 50% of the Age III rainbow trout. Sufficient suitable spawning habitat should be maintained to reach this objective. The total populations of rainbow trout (age II plus) in this reach should be maintained at approximately 100,000 fish as determined from population estimation. Rainbow trout should achieve 18 inches in length by Age III with a mean relative weight (Wr) of at least 0.80.**

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#### **Original Information Needs for Trout MO #5:**

1. **Determine ecosystem requirements, population character and structure to maintain reproduced populations of Age II plus fish at 50,000 - 100,000 population levels**
2. **Monitor changes in population character and structure**
3. **Monitor harvested and field sampled rainbow trout to determine the contribution of**

naturally reproduced fish to the population

4. Monitor the availability and quality of spawning substrates in the Glen Canyon reach
5. Monitor the size of the population of age II plus rainbow trout in the Glen Canyon reach
6. Monitor the growth and condition of rainbow trout in Glen Canyon
7. Define criteria for healthy trout population

### Non-Native Warm Water and Cool Water Fishes

#### MO 7.6

Minimize, to the extent possible, interactions between native and non-native fishes.

*(Accepted as is 2-24. Originally MO #5)*

**SIN 7.1: Determine impact of flows on listed and native fish fauna.**

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Original IN's for this MO:

1. Define areas and conditions of current and future existing and potential interactions
2. Monitor key attributes associated with interaction
3. Determine methods for minimizing interactions through isolation
4. Determine methods for minimizing interactions without isolation
5. Monitor the species composition, relative abundance, and size class structure of non-native fishes in the Colorado River and important tributaries
6. Identify existing and potential sources of interaction (predatory, competitive) between extant non-native fishes and native fishes of the Colorado River and important tributaries
7. Evaluate the effects of beach/habitat building flows and habitat maintenance flows on the distribution and abundance of non-native fishes in the Colorado River and important tributaries

**8. Identify potential alternative strategies to suppress problematic non-native species in the Colorado River and important tributaries**

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**Aquatic Food Base**

**MO 8 7**

Maintain and enhance the aquatic food base in the Colorado River ecosystem to support desired populations of native and non-native fish. Glen Canyon: At a minimum, maintain continuously inundated areas for Cladophora and aquatic invertebrates at or above 5,000 cfs discharge levels.

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**Original Info Needs for this MO:**

1. Define current and historic food base character and structure
  2. Define food base character, structure and requirements for maintaining target populations
  3. Determine system changes to maintain/ enhance food base
  4. Define impacts of alternative operating criteria on ecosystem (food base)
  5. Monitor the species composition and the distribution of aquatic algae and macrophytes in the Colorado River
  6. Monitor the species composition and density of macroinvertebrates in the Colorado River
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**Reasonable and Prudent Alternative**

**MO 9**

Evaluate through monitoring and research the effectiveness of the Reasonable and Prudent Alternative specified by the Fish and Wildlife Service to remove jeopardy for the Humpback Chub and Razorback Sucker in the Colorado River ecosystem as follows:

*(this was previously the 8 series on 2-25-98)*

*(Previous MO #8a deleted here and added to Native Fish as MO #5)*

- SIN 9.1 Implement selective withdrawal program for Lake Powell waters. (*Suggestion from Tony Morton: should this be a Management Action?*)
- SIN 9.2 Remove jeopardy for Humpback Chub and Razorback Sucker in the Colorado River ecosystem. (*Suggestion from Tony Morton: Is this part of the Objective?*)
- SIN 9.2 Prepare a set of possible scenarios of temperature changes in the mainstem.
- SIN 9.3 Determine the anticipated effects on native populations which may result from implementation of temperature changes from a selective withdrawal structure. Determine the range of temperatures for successful larval fish development and recruitment and the relationship between larval/juvenile growth and temperature.
- SIN 9.4 Assess the temperature induced interactions between native and non-native fish competitors and predators. Assess the effects of temperature, including seasonality and degree, on Cladophora and associated diatoms, *Gammarus*, aquatic insects, and fish parasites and disease.
- SIN 9.5 Evaluate effects of withdrawing water on the heat budget of Lake Powell, effects of potentially warmer inflow into Lake Mead, and the concomitant effects on the biota within both reservoirs. Evaluate the temperature profiles along with heat budget for both reservoirs. Evaluate effects of reservoir withdrawal level on fine particulate organic matter and important plant nutrients to understand the relationship between withdrawal level and reservoir and downstream resources.
- SIN 9.6 Evaluate when to release warmer temperature water, what seasonal pattern of releases to use to avoid establishment of permanent backwater areas, and how best to use floods, to limit expansion or invasion of non-native fish species. (RPA 1B)
- SIN 9.7 Determine the effects of water temperature on reproductive success, growth, and survivorship of Grand Canyon fishes.
- SIN 9.8 Determine origins of fish food resources, energy pathways, and nutrient sources important to their production, and the effects of Glen Canyon Dam operations on these resources.
- SIN 9.9 Determine the effects of dam operations, including modifications to regulate water temperatures, on the parasites and disease organisms of endangered and native fishes in Grand Canyon. using various flow and temperature scenarios to determine cause and effect relationships between dam operations and responses of the community of endangered and native fishes endemic to the Grand Canyon.

SIN 9.10 Track the status of native fishes in Grand Canyon. Relevant indices should be developed and measured in support of the long-term monitoring plan. (RPA 1C)

### MO 9.1

Attain riverine conditions that support all life stages of endangered and native fish species.

- SIN 9.1.1 Determine humpback chub life history schedule for populations downstream of Glen Canyon Dam.
- SIN 9.1.2 Develop and implement a program to evaluate effects of factors limiting overwintering survival of young-of-year humpback chubs in the Grand Canyon. The program shall evaluate the implications of high flows, habitat restrictions, predation, reduced sediment loads, and cold water temperatures. (Fall 97 Test Flow T&C 1) This is to include specific hypotheses as follows:
- SIN 9.1.2a test flows do not significantly reduce densities of young-of-year humpback chub; and
- SIN 9.1.2b test flows do not significantly affect/alter nearshore habitats used by native fishes (Fall 97 Test Flow T&C 2)
- SIN 9.1.3 Quantify to the extent possible the effects of spring high steady flows and summer and fall low steady flows on endangered and native fish.
- SIN 9.1.4 Determine relationships among tributary hydrology, reproductive success of fishes, and the abundance of fishes in mainstem rearing habitats.
- SIN 9.1.5 Determine the effects of mainstem hydrology on the number of nearshore rearing habitats, environmental conditions in these habitats, and their successful utilization by fishes.
- SIN 9.1.6 Assess biotic interactions between native and non-native fishes, particularly those that occur in nearshore rearing habitats affected by dam operations.
- SIN 9.1.7 Design and implement a program to evaluate and assess factors determining young-of-year humpback chub recruitment. *(Note: half of MA 9.1.1's paragraph was relocated here as an info need.)*
- MA 9.1.1 ~~Limit future test flows (i.e., 25,000 cfs and greater) from October through February until a program has been designed and implemented to evaluate and assess factors determining young-of-year humpback chub recruitment.~~ *(Note: ~~strikeout~~ section was put under information need 9.1.7 above)*

**\*MA 9.1.2** Monitoring of the project area and other areas that could be affected by the proposed action shall be done to ascertain take of individuals of the species and/or of its habitat that causes harm, harassment, or death to the species. This monitoring will be accomplished using the following protocol:

**MA 9.1.2a** "A Draft Proposal to Assess, Mitigate and Monitor the impacts of an Experimental High Flow from Glen Canyon Dam on the Endangered Kanab Ambersnail at Vaseys Paradise, Grand Canyon, Arizona" (Stevens *et al.* 1995b).

**MA 9.1.2b** In order to more accurately determine elevation of river stage at the range of flow that will be experienced during the test flow, and for use in developing a stage discharge relationship for future flow, the placement of a stage recorder, such as a pressure transducer coupled to a recorder should be deployed, if possible, in the mainstem at an appropriate site near the Kanab ambersnail population. The U.S. Geologic Survey should be contacted regarding the possibility of changing the location of a stage recorder to be used in test flow studies to the Kanab ambersnail site.

**MA 9.1.2c** SALVAGE PROTOCOL. Kanab ambersnail specimens found dead, or taken as part of research activities, shall be collected and held as specified in the AGFD permit, with final deposition in a suitable museum collection such as at Northern Arizona University (1996 BHBFKAS T&C 1)

### **MO 9.2**

Protect humpback chub spawning population and habitat in the Little Colorado River by being instrumental in developing a management plan for the Little Colorado River. (*this is #2 in the RPA*).

No information needs for 9.2.

### **MO 9.3**

Help ensure the continued existence of the razorback sucker.

**SIN 9.3.1** Investigate opportunities to establish razorback suckers in the Grand Canyon, including development of spawning and rearing areas that would function like flooded river bottom lands. (RPA 3)

**MO 9.4**

Establish a second spawning aggregation of humpback chub downstream of Glen Canyon Dam. (this eliminates original mgmt objective #3 on the 2nd pop of HBC)

**MO 9.5**

Maintain sediment-dependent native fish nearshore habitats. (Incidental Take and Terms & Conditions 2). *(replaces MO #4 on original objectives.)*

- SIN 9.5.1 Use studies associated with the proposed test flow that include determination of effects on physical habitat used by young fishes, food base, and direct effect on larval, juvenile, and adult native and non-native fishes to develop methods to detect changes in numbers of humpback chub or their habitat. (1996 BHBF HBC RPM 3)
- SIN 9.5.2 Develop a method to determine the number of humpback chubs suspected to be lost during special flows and the relationship of this loss to the Grand Canyon population. (Incidental Take and T&C 1)
- SIN 9.5.3 Develop a strategy to sustain notable year classes of humpback chubs that are susceptible to being transported downstream into unfavorable habitats. (Incidental Take and T&C 2)
- SIN 9.5.4 Acquire an understanding of the frequency of HBC year classes in the system susceptible to being transported downstream into unfavorable habitats and impact of flows on that year class. (Incidental Take and T&C 2)
- SIN 9.5.5 Determine impacts of flows on young humpback chubs during study flows, and develop methods of detecting changes in numbers, to assist in establishing levels of incidental take. (Incidental Take)
- SIN 9.5.6 Develop biological criteria governing the implementation of special flows that will assure that the level of incidental take of HBC is not exceeded. (Incidental Take)
- MA 9.5.1 Conduct the test flow BHBFs during a periods that avoids concentrations of young-of-year humpback chub (1996 BHBF HBC RPM 1)
- MA 9.5.2 A report of the results of the monitoring, including complete and accurate records of all incidental take that occurred during the course of the project, will be submitted to the Service the same date that a draft and final is submitted to Reclamation. Progress reports provided to Reclamation will

also be provided to the Service. This report will also describe how the terms and conditions of all reasonable and prudent measures in this incidental take statement were implemented, including any deviations from the test flow and explanation for need to change. (1996 BHPF T&C 2)

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**Original Info Needs for RPAs:**

- 1. Using monitoring and research programs evaluate all test flows in RPA and potential impacts to threatened and endangered fisheries**
  - 2. Determine the benefits and impacts of installing selective withdrawal for thermal modification in the mainstem of the Colorado River downstream of Glen Canyon Dam**
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## RECREATION

**Goal:** To provide quality recreation experiences that do not adversely affect natural or cultural resources within the river corridor.

**Definition:** Recreation resources include sport fishing, white water rafting, boating, hiking, sightseeing and photography.

**Examples:** Trout fishing, White water rafting, Boating, hiking, sightseeing, Photography

## MANAGEMENT OBJECTIVES, STAKEHOLDER INFORMATION NEEDS, MANAGEMENT ACTIONS

### MO 1

Provide quality recreation experiences consistent with other resource objectives. Maintain or improve the wilderness character of the recreational experience.

**MA 1.1** Utilize approaches for monitoring and research that are appropriate to maintain or improve the character of the recreational experience as defined in NPS management plans for those areas.

**MA 1.2** Ensure water release strategies and communications systems that support and enhance the full range of river recreation experiences allowed under NPS management plans for those areas.

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### Original IN's

1. Determine criteria and aspects that are important to or detract from wilderness experience
  2. Determine the impacts of scientific study on wilderness experience
  3. Characterize procedures to mitigate those aspects of flows that detract from wilderness character of river
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**MO 2**

Maintain flows and sediment processes that create an adequate quantity, distribution and variety of beaches for camping, as long as such flows are consistent with management of natural recreation and cultural resource values (other natural resource values).

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**Original IN's**

1. **Determine adequate beach quality, character and structure for camping throughout system**
2. **Evaluate impacts of operating criteria on establishing and maintaining adequate beaches and distribution of other resources, quality, character and structure**
3. **Monitor beach character and structure changes**
4. **Develop systems models to predict flow regimes for building and maintaining beaches**

**MO 3**

Maintain flows that do not preclude minimize impacts to navigability by authorized water craft in Grand Canyon and power craft in Glen Canyon and upper Lake Mead and safe access and for boaters, waders, and campers in the riverine corridor.

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**Original IN's**

1. **Determine if operating criteria maintains safe and adequate powercraft navigability in Glen Canyon and upper Lake Mead**
2. **Evaluation efforts of operating criteria on recreation safety**
3. **Determine if operating criteria maintains whitewater raft navigation in Grand Canyon**
4. **Define ecosystem and other resource impacts of flow regimes to maintain navigation**

**MO 4**

Maintain flows and habitat suitable for quality cold water fishery opportunities in Glen Canyon.

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**Original Information Needs/MO #4:**

1. Determine flow regimes necessary to maintain fish populations of 100,000 adult Trout (age class II plus)
2. Determine impacts of operating criteria on other resources and ecosystems

**MO 5**

Maintain flows and habitat suitable for waterfowl sport hunting and wildlife viewing opportunities for water fowl in Glen Canyon.

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**Original Information Needs/MO #5:**

1. Define pattern of waterfowl and other wildlife use and conflicts to other uses

## RIPARIAN & TERRESTRIAL VEGETATION

**Goal:** To maintain where possible existing remnants of native communities.

**Definition:** Riparian and terrestrial vegetation includes both native and non-native plant species, and include natural species; balanced successional stages; unique plants and threatened and endangered plants.

### MANAGEMENT OBJECTIVES, STAKEHOLDER INFORMATION NEEDS, MANAGEMENT ACTIONS

#### MO 1

**Maintain Encourage** dynamic vegetative communities made up of diverse groups of native riparian and upland species (where affected by dam operations) at different stages of succession and at different elevations above the water line.

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#### **Original Information Needs:**

**SIN 1.1** *(Note: This was previously an overall objective; Group to decide information needs.)*

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#### MO #12

**Preserve or restore** (where possible) natural **Understand** species composition and abundance within riparian and upland communities affected by dam operations.

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#### **Original Information Needs:**

**SIN 2.1** **Determine historical natural composition of riparian and upland communities**

**SIN 2.2** **Characterize normal range of variation and ecology of species**

**SIN 2.3** **Monitor impacts of operating criteria on the succession processes of natural vegetation communities**

**SIN 2.4** **Evaluate impacts of dam operations on establishment of and impacts from exotic plant species**

**SIN 2.5** **Evaluate impacts to vegetation communities of alternate aspects of operating criteria**

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**MO #2.3**

Emphasize the preservation of unique the perpetuation of plant communities and any special status species (federal, tribal, and state designations) to ensure their perpetuation continued existence within the system.

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**Original Information Needs**

- SIN 3.1 Determine historic and current distributions, range of variation and ecology of T&E and special status species**
  - SIN 3.2 Establish ecosystem requirements of special status species and determine probable impacts of proposed flow regimes**
  - SIN 3.3 Monitor population changes in special status species**
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**LAKE POWELL**

**Goal:** To understand impacts of Dam operations and where possible minimize these impacts, consistent with other resource objectives.

**Definition:** The Lake Powell program includes natural, biological and cultural resources impacted by operation of Glen Canyon Dam.

**MANAGEMENT OBJECTIVES, STAKEHOLDER INFORMATION NEEDS, MANAGEMENT ACTIONS****MO 1**

**Assessment of resource change due to operations criteria:** Minimize the impacts downstream of changes in Lake Powell caused by dam operations.

**MO 2**

**Continue assessment of historical chemical and biological data:**  
(*Note: decision made to step this down in the Information Needs.*)

**Management Objective 3.0**

Develop conceptual modeling.

**Management Objective 4.0**

Develop fish impact issues.

**Information Needs for Lake Powell:**