

**FISCAL YEAR 1998**  
**ANNUAL MONITORING AND RESEARCH PLAN**

by

**THE GRAND CANYON MONITORING AND RESEARCH CENTER**

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1 to accomplish objectives and information needs specified by the stakeholders and outlined in the  
2 Strategic Plan.

3  
4  
5 The FY98 Annual Plan is best understood in the context of the Strategic Plan.

6 Although some elements of the Strategic Plan are not contained in the FY98 Annual Plan, all  
7 the major resource areas of investigation, as well as programs on information technology, are  
8 included.

9 The following summary of the Strategic Plan program goals provides a brief introduction  
10 to the plan, as well as an overview of each major element of the plan.

#### 11 **AN OVERVIEW OF THE STRATEGIC PLAN: 1998-2002**

12 The Strategic Plan is designed to implement new concepts of adaptive management and  
13 ecosystem science called for in the GCPA and GCDEIS. The areas of monitoring, research, and  
14 information technology outlined for physical, biological, cultural, and socioeconomic resources  
15 will be implemented over a five-year period. Annual program plans are required to assure  
16 appropriate progress on critical elements of the Strategic Plan.

17 All elements of the Strategic Plan, and all monitoring programs, research projects, and  
18 information technologies drafted into annual program plans, incorporate the ecosystem science  
19 paradigm and are developed cooperatively with the AMWG. All proposed programs relate to  
20 determined or potential resource impacts in the riverine corridor associated with the Secretary  
21 of the Interior's decisions and the GCDEIS.

1 Independent reviews of past research in Grand Canyon have concluded that several  
2 issues need to be addressed to ensure progressive future monitoring and science programs that  
3 associate changes in critical resources to dam operations. These include:

- 4 1. Development of an adaptive management and science process to permit close  
5 interaction of science and management in evaluating potential new management  
6 criteria and impacts of those criteria in shorter time periods.
- 7 2. Development of a conceptual model of Grand Canyon riverine ecosystems that  
8 can be used to more clearly define critical attributes and linkages within and  
9 between resource categories, and interdependencies of resource attributes.
- 10 3. An extensive synthesis of all past knowledge associated with original baseline  
11 resource conditions in the Colorado River, riverine resource changes associated  
12 with construction of Glen Canyon Dam, and changes associated with differing  
13 operating criteria for Glen Canyon Dam.
- 14 4. Ecosystem analyses to promote improved understanding of critical attributes that  
15 drive individual resources and groups of resources, and the interdependencies of  
16 attributes within and across resources.
- 17 5. Development of predictive models of ecosystem functions and interactions under  
18 differing dam operating criteria.

19 **MISSION AND SCOPE OF GCMRC**  
20 **AND THE STRATEGIC PLAN**

21 The GCPA and GCDEIS directs the Secretary of the Interior, "To establish and  
22 implement long-term monitoring programs and activities that will ensure that Glen Canyon Dam

1 is operated in a manner consistent with that of Section 1802" of the GCPA. The mission of the  
2 GCMRC and goals of this Strategic and Annual Plan are to define monitoring and research  
3 programs that will evaluate short- and long-term ecosystem resource impacts of "...the effects of  
4 the Secretary's actions..." and other information needs specified by the AMWG and Secretary of  
5 the Interior.

6 Long-term monitoring of all resources of concern will occur to determine significant  
7 changes in resource attributes. Research will be used to interpret and explain trends observed  
8 from monitoring, to determine cause and effect relationships and research associations, and to  
9 better define interrelationships among physical, biological and social processes. In addition to  
10 monitoring and research activities, the GCMRC will develop information technologies to assure  
11 information archiving and transfer to managers, stakeholders and science organizations.

12 The physical scope of the research area to be investigated by the GCMRC includes the  
13 Colorado River mainstem corridor and associated riparian and terrace zones from the forebay of  
14 Glen Canyon Dam to the lower boundary of Grand Canyon National Park, a distance of  
15 approximately 293 river miles. The research scope does include limited investigations into some  
16 tributaries such as the Little Colorado and Paria rivers. It also includes, in general, resource  
17 impacts of dam operations up to inundation levels associated with flows of 100,000 cubic feet  
18 per second (cfs). ~~the 100-year predam flood level.~~

19 An assessment of dam operation impacts to water quality in Lake Powell will be  
20 completed in FY97, and any future monitoring and research investigations in either Lake Powell

1 or Lake Mead must be directly associated with impacts attributable to Glen Canyon Dam  
2 operating criteria.

3 **STAKEHOLDER INFORMATION NEEDS**  
4 **AND CRITICAL RESOURCE ATTRIBUTES**

5 The Strategic Plan was established to respond to the general objectives and information  
6 needs of managers and stakeholders regarding Glen and Grand Canyon and their resources.  
7 Objectives and information needs of stakeholders are specified in nine resource areas including:  
8 hydropower, water, sediment, fish and aquatic biology, vegetation, threatened and endangered  
9 species, terrestrial wildlife, cultural resources, and recreation (Figure 1).

10 Within each of the above resource areas, specific objectives were developed  
11 cooperatively by the Bureau of Reclamation (BOR) and representatives of the AMWG. Detailed  
12 information needs for various objectives and resource areas were defined by representatives of  
13 the AMWG working cooperatively with the GCMRC. These objectives and information needs  
14 may be found in the Strategic Plan.

15 **PROPOSED MONITORING AND SCIENCE PROGRAMS**

16 Monitoring and science programs proposed in the Strategic Plan include significant  
17 activities in the following:

- 18 1. Conceptual modeling and synthesis of existing knowledge.
- 19 2. Physical resource program.
- 20 3. Cultural resource program.
- 21 4. Biological resource program.
- 22 5. Socioeconomic resource program.

1           6.     Information technology program.

2     Each of these areas represent components of the long-term program from which information will  
3     be developed to address objectives and information needs specified by stakeholders.

4     **Conceptual Modeling and Synthesis of Existing Knowledge**

5           The synthesis of existing ~~knowledge~~ ~~data and information~~ has two primary components  
6     and will be completed in the first two to three years of the first five-year plan. The first  
7     component is development of a conceptual model of Colorado River ecosystems primarily  
8     between Glen Canyon Dam and Lake Mead . The intent of the model will be to examine  
9     resource elements that respond to variable operating criteria of Glen Canyon Dam. The second  
10    component of the synthesis program is the detailed assessment of most past research associated  
11    with the riverine corridor's resources after and possibly before Dam construction, as well as  
12    other unregulated western riverine corridors, that are of similar character and structure to the  
13    Colorado River mainstem. These syntheses are addressed in the individual resource program  
14    areas.

15           Completion of this comprehensive in-depth synthesis will provide an important tool for  
16    organizing our understanding of this riverine ecosystem and the impacts of flow regulation.  
17    Anticipated endproducts include a more ~~profound~~ integrated data assessment and interpretation  
18    of critical alternatives associated with resources of concern, and a major comprehensive transfer,  
19    from GCMRC, of information to stakeholders regarding the potential impacts of ~~differing~~  
20    ~~alternative~~ operating criteria on riverine ecosystems and associated resources.

## 1     **The Physical Resources Program**

2             Water and sediment are the two primary resources of concern in the physical resources  
3 area although there are potential associated impacts to other resources. Monitoring and research  
4 efforts will concentrate on four areas of impact of dam operations as follows:

- 5             1.     Dam discharges and instream flows.
- 6             2.     Sediment balance and processes, including upper terrace deposits.
- 7             3.     Mainstem flow and sediment and tributary input (primarily the Little Colorado  
8                 and Paria Rivers) interrelationships and relationships to other resources.
- 9             4.     Interaction of mainstem flow and sediment outflow and Lake Mead resources.

## 10    **The Biological Resources Program**

11            Monitoring and research of biological resources is intended to continue and refine  
12 collection of data on critical components of the Transition Monitoring Program while providing  
13 ~~new~~ **additional** information about the structure and function of Colorado River ecosystems, as  
14 well as the impacts of a range of alternative dam operations on the ecosystem and associated  
15 flora and fauna. The biological resources program needs to be linked to the physical resources  
16 program to facilitate the understanding of the influence of abiotic factors on biotic resources (i.e.,  
17 discharge and sediment on **the aquatic food base and fish habitat**).

18            Programs will evaluate native and non-native fish population dynamics to assess the  
19 native and non-native fish communities' responses to alternative dam operations and criteria.  
20 Native fish species of concern are the humpback chub, razorback sucker, flannelmouth sucker,  
21 bluehead sucker and speckled dace. Non-native species of current interest as

1 predators/competitors of native fish include several species of Salmonidae, Ictaluridae,  
2 Cyprinidae, ~~Cyprinidae~~ and Percichthyidae. , and Percidae.

3 Monitoring of the non-native trout fishery in the Lees Ferry reach will concentrate on  
4 growth, survivorship, recruitment, and changes in population structure, including the contribution  
5 from natural reproduction over time and angler use. Monitoring of other non-native fish  
6 populations will be carried out in conjunction with ongoing native and non-native fish  
7 monitoring activities.

8 Changes in species composition and vegetative area in the three primary riparian zones  
9 along the river will be monitored including, the upper riparian zone, lower riparian zone, and  
10 hydro-riparian wetland communities

11 Monitoring of threatened and endangered species will remain a priority for GCMRC. For  
12 example, with respect to the Kanab ambersnail monitoring and research activities will address  
13 the population age structure analysis, diet analysis, and habitat requirements.

14 Avifauna monitoring will emphasize the southwestern willow flycatcher and general  
15 riparian avifauna surveys (e.g., wintering and breeding waterfowl, riparian obligate species,  
16 resident non-obligate species, and migrant species).

### 17 **The Cultural Resources Program**

18 This program will address information needs of the AMWG relative to cultural resources  
19 at the direction of parties to the Programmatic Agreement (PA), who are also AMWG members.  
20 Activities that are a part of the ongoing PA program may be included. Monitoring and research

1 information needs and activities from the PA are expected to be a major component of the  
2 Strategic Plan.

3 The cultural resources program for the GCMRC will accommodate three primary  
4 components: **a core program, a tribal projects element, and a cooperative programming**  
5 **aspect.** Objectives and information needs specified by the stakeholders have been utilized to  
6 incorporate the following monitoring and research proposals in the Strategic Plan.

- 7 1. Assess existing and develop additional data and monitoring systems to assess  
8 impacts.
- 9 2. Assess existing and develop additional data to assess risk of damage and loss of  
10 cultural resources from varying flow regimes from 45,000 cfs to 100,000 cfs.
- 11 3. Assess existing and develop additional tribal monitoring programs for evaluation  
12 of impacts to cultural resources.
- 13 4. Assess existing and test local and reach-scale predictive model of geomorphic  
14 processes that are related to archeological site erosion.
- 15 5. Assess existing and develop additional mitigating strategies related to documented  
16 dam impacts determined by monitoring assessments.
- 17 6. Characterize resources through scientific study.

### 18 **The Socio-economic Resources Program**

19 There are many socio-economic resources associated with the Grand Canyon riverine  
20 environment including recreation and camping beaches, electric power and water. In recreation,  
21 the objectives of long-term monitoring and research will be to ~~determine whether~~ **study**

1 recreational ~~attitudes and wilderness experiences, and safety issues relative to~~ ~~is enhanced and~~  
2 ~~safety improved when evaluating differing~~ ~~alternative~~ dam operation strategies.

3 Camping beach changes will be determined by monitoring changes in sand bar areas and  
4 elevations using remotely sensed data and cooperative programs with boating guides and their  
5 associations.

6 Hydropower generation ~~is currently compiled at the Dam and these data will be used in~~  
7 ~~will be monitored as input to~~ assessing the consequences of dam operations on power  
8 economics.

9 ~~In research, a Cost Benefit Analysis (CBA) model is proposed, to accommodate~~  
10 ~~evaluation of all associated market and non-market costs and benefits, including intrinsic and~~  
11 ~~existence values of key resources.~~

## 12 **Information Technology**

13 Extensive data and information currently exist in the GCMRC collections relating to  
14 resource conditions, quality, and relationships to other resources. Potentially equal amounts of  
15 data and information exist within museums, universities, agencies, etc. However, much of this  
16 information has not been organized, managed or integrated into an analysis of the  
17 interrelationship among various resources and dam operations.

18 The following areas will be implemented in the information technology program:

- 19 1. Development of protocols for data collection, processing and use.
- 20 2. Development of extensive multidisciplinary databases and a database  
21 management system.



1           3.     Development of decision support guidelines and models to assist managers and  
2                     interested stakeholders to understand resource interactions, impacts of dam  
3                     operations on resources and procedures for mitigating impacts.

4           Budget for the Annual Plan is anticipated at approximately seven million dollars. Of the  
5     total seven million dollar budget allocation, approximately \$5.0 million will be directed to  
6     monitoring and research programs. Approximately one-half million is required by the Upper  
7     Colorado Region of BOR to administer the adaptive management program, and approximately  
8     \$1.5 million is required to operate all GCMRC's administrative programming.

## CHAPTER 2

### DEVELOPING STAKEHOLDER INFORMATION NEEDS FOR THE FY98 ANNUAL PLAN

#### DEVELOPING STAKEHOLDER OBJECTIVES

In 1996 the Bureau of Reclamation worked with a subgroup of the Transition Work Group to develop stakeholder objectives to guide future monitoring and research programs of the GCMRC. This group was disbanded with release of their July, 1996<sup>1/</sup> recommendations.

The objectives developed lie in nine resource areas (Figure 1). All of the objectives may be found in the Strategic Plan.

#### DEVELOPING INFORMATION NEEDS

A series of meetings were held between May and October 1996 to define information needs (research, monitoring) of stakeholders who are involved with protection, management, and use of resources in the riverine environment of Grand Canyon National Park and Glen Canyon National Recreation Area. The group of stakeholders involved were identified as an Information Planning Group<sup>2/</sup> to the GCMRC. An average of 20 stakeholders attended eight six-hour

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<sup>1/</sup> Adapted from *Glen Canyon Dam Management Objectives*, Bureau of Reclamation memorandum UC-205, ADM-1.10, July 1996, to Transition Work Group members.

<sup>2/</sup> The Information (Planning Group), a cross section of representatives from the Transition Work Group developed the information needs specified. The workshops held by the Information (Planning) Group were facilitated by the GCMRC.



Figure 1. Objectives resource areas identified for research and monitoring.

1 workshops to develop the information needs

2 A synopsis of the information needs in each resource area is presented in the following  
3 text. These expressed needs are the primary basis for developing Fiscal Year 1998 monitoring,  
4 research, and information transfer programs for the GCMRC. In the cultural resource area, some  
5 information currently exists based on the ongoing PA program. However, this program is more  
6 limited in scope than the GCMRC cultural program.

### 7 **Water Resources**

- 8 • Monitor changes in water quality (physical and chemical characteristics such as  
9 temperature, salinity, nutrients, and trace elements) over time and space.
- 10 • Monitor concentrations of chemical constituents in comparison with historical  
11 levels, requirements of the aquatic ecosystem, and with established EPA/state and  
12 Tribal standards.
- 13 • Measure water composition and temperature and their changes over time and  
14 space.

### 15 **Sediment Resources**

- 16 • Characterize terrace, sand-bar, backwaters, and return channel structures.
- 17 • Define target backwater ecosystems and associated flow regimes.
- 18 • Define character and structure of terraces with cultural properties and of all  
19 beaches and backwaters in system after 1996 test flows.
- 20 • Define historical and current (character and structure) levels of river stored  
21 sediment in system and associated flow regimes.

- Determine baseline conditions.

## **Cultural Resources**

- Develop data and monitoring systems to assess impacts to cultural resources.
- Develop predictive model of geomorphic processes related to archaeological site erosion including:
  - ▶ Types of degradation
  - ▶ Rates of degradation
- Define immediacy of threats to resources
- Protection methodologies
- Protection, monitoring and research costs
- Characterize through scientific study and data development all defined historical and current values of resources to tribal nations and to general public.
- Characterize historic and current religious associations of all sites associated with impacts of dam operating criteria.
- Characterize all cultural resource sites as to the specific associated management/research needs, i.e.; preservation, stabilization, documentation, etc.; under alternative operating criteria.
- Develop Tribal monitoring programs for evaluation of resource impacts.
- Develop mitigation strategies relative to documented site impacts.

1 **Fish And Aquatic Resources**

- 2 • Improve monitoring protocol for adult Humpback Chubs populations and evaluate  
3 population trends.
- 4 • Determine historic and current character and structure of species populations.
- 5 • Conduct studies of temperature, habitat availability and use of mainstem and  
6 tributary habitats by native fish.
- 7 • Determine importance of backwaters to native fish.
- 8 • Develop criteria for self sustaining populations of humpback chub.
- 9 • Monitor harvested and field sampled rainbow trout to determine the contribution of  
10 naturally reproduced fish to the population.
- 11 • Determine impacts of dam operations on trout redds.
- 12 • Define areas and conditions of current and future existing and potential interactions  
13 between native and non-native species.
- 14 • Define current and historic food base character and structure.
- 15 • Design and test an experimental program of steady flows to verify an effective flow  
16 regime and quantify, to the extent possible, effects on endangered and native fish.
- 17 —• Evaluate all test flows in RPA and potential impacts to threatened and endangered  
18 fisheries.

19 **Riparian And Terrestrial Vegetation Resources**

- 20 • Determine historic natural composition of riparian and upland communities.
- 21 • Characterize normal range of variation and ecology of species.

- 1 • Monitor impacts of dam operating criteria on the successional processes of natural  
2 vegetation communities.
- 3 • Evaluate impacts of dam operations on establishment of and impacts from exotic  
4 plant species.
- 5 • Evaluate impacts of alternate dam operating criteria on vegetation communities.
- 6 • Determine historic and current distributions, range of variation and ecology of T&E  
7 and special status species.
- 8 • Establish ecosystem requirements of special status species and determine probable  
9 impacts of proposed flow regimes.
- 10 • Monitor population changes in special status species.

#### 11 **Native Terrestrial Wildlife Resources and Habitat**

- 12 • Define and specify ecology of native faunal components, especially threatened and  
13 endangered species.
- 14 • Determine, where possible, species' natural ranges (pre and post dam).
- 15 • Define food chain associations, interdependencies, requirements, etc., for native  
16 species population targets.
- 17 • Characterize historic and current expected use by species.
- 18 • Characterize historic and current populations of Kanab Ambersnail and their  
19 locations.
- 20 • Determine range of natural variability/ecology and ecosystem requirements of  
21 wildlife occupying the Canyon.

#### 22 **Socio-Economic Resources**

- 1 • Determine criteria and aspects that are important to or detract from wilderness  
2 experience.
- 3 • Determine adequate beach quality, character and structure for camping throughout  
4 the system.
- 5 • Determine if operating criteria maintains safe and adequate powercraft navigability  
6 in Glen Canyon and upper Lake Mead.
- 7 • Determine flow regimes necessary to maintain fish populations on 100,000 adult  
8 trout (age class II plus).
- 9 • Define pattern of waterfowl and other wildlife use and conflicts to other uses.



## CONCEPTUAL MODELING

As part of the overall synthesis to guide monitoring and research programs in each resource area, a conceptual model will be designed to represent Colorado ecosystems, resources and resource attribute linkages. This systems model will be used to guide monitoring and research planning, define attribute linkages, characterize key attributes, and make qualitative assessments of resource change from **changing alternative** dam operations. All of the programs will contribute to the conceptual modeling activities.

The following approach is being proposed for use by the GCMRC in developing the needed conceptual and strategic models of the system. The GCMRC will assemble or contract with a group of modelers to lead the development of the desired conceptual model. The GCMRC, together with the modeling team, will convene a scoping meeting to define the scope of the problem, design the first of two subsequent modeling workshops, identify key people (scientists and stakeholders) to participate in the modeling workshops, and begin to assemble the information that will be used in the first workshops.

The conceptual model will be designed using scientists and stakeholders currently active in Grand Canyon programs through a modeling workshop process (Hollings 1978, Garrett 1986). Scientists and stakeholders will be brought together to define resource variables/attributes that serve as linkages between/among resources. This "looking outward matrix" specification of resources, their attributes and the attribute linkages to other resources are building blocks for the conceptual system (Fight et al. 1986). Figure 2 provides an example of this matrix for an anadromous fisheries submodel of a conceptual systems model.

1           Following the scoping meeting, GCMRC will convene an initial modeling workshop to  
2 develop explicit relationships among attributes. This workshop will involve scientists and  
3 stakeholders knowledgeable about the Grand Canyon ecosystem. Extensive information bases  
4 including maps, databases, published reports, etc., will be necessary for this workshop. The  
5 goal for this workshop will be to produce a conceptual model of the system based on critical  
6 relationships which structure the system, identify key information gaps, and suggest initial  
7 priorities for a long-term monitoring and research program.

8           A second modeling workshop of equal length will be necessary to refine the conceptual  
9 model and develop a strategic simulation model with first approximation parameter estimates,  
10 that can be used to evaluate resource responses (e.g., native fishes) to different management  
11 strategies. Three to six months is required between the first and second modeling workshops to  
12 validate and refine submodels, develop additional needed data and information, and where  
13 needed specify necessary subcomponents of submodels.

14           During the second workshop the process of assigning more definitive co-efficient values  
15 to what are believed to be key model parameters would begin, as well as model validation and  
16 sensitivity analysis to test key assumptions embedded in the model. Analysts would begin to  
17 explore the consequences of alternative dam operations based on the assumptions and hypothesis  
18 used to construct the model. This second workshop would yield a first approximation strategic

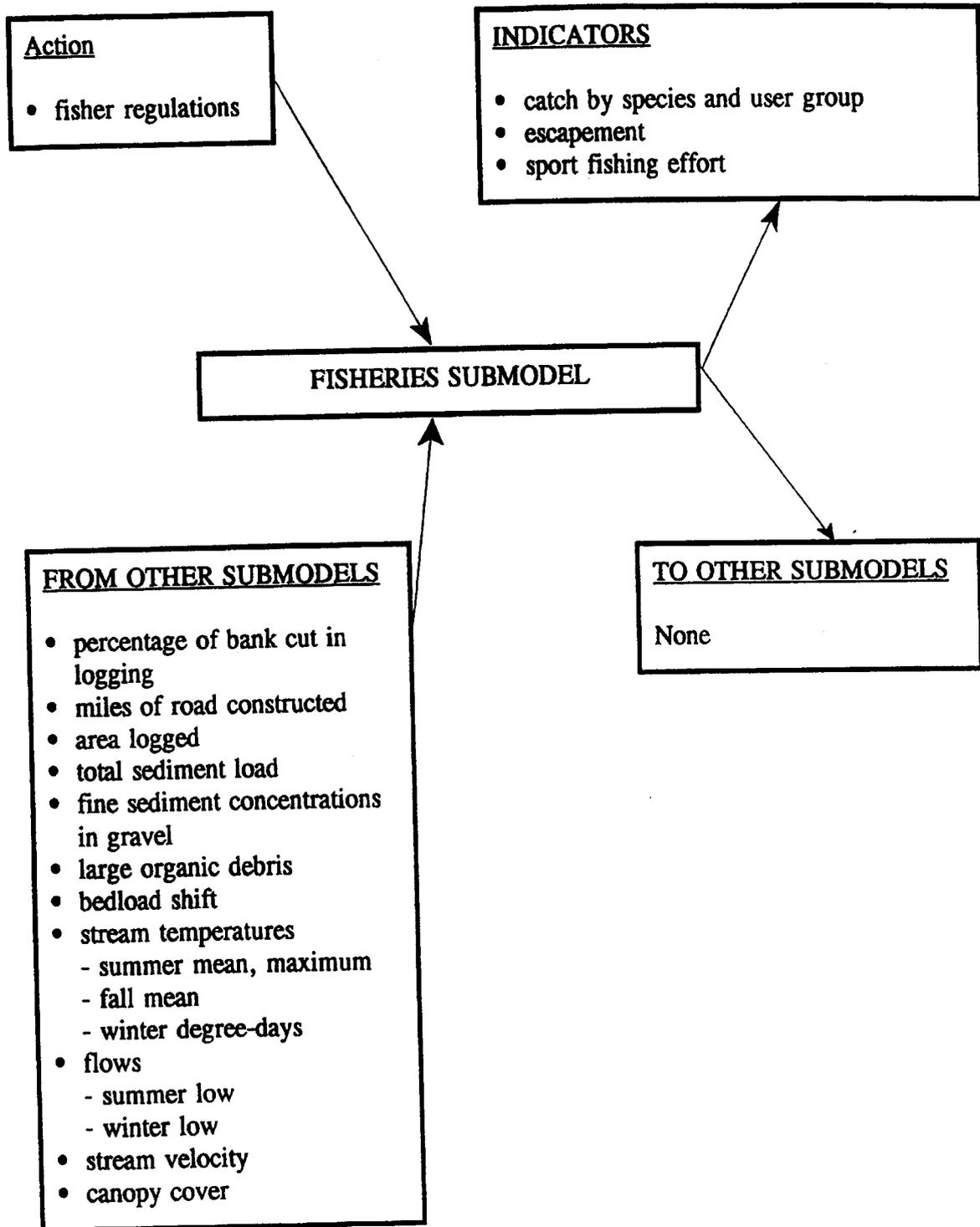


Figure 2. A "Looking Outward Matrix for Fisheries Resources in the Southeast Alaska Multi resource Model" (adapted from Fight et. al., 1986).

1 model that, in association with new synthesis information being developed, will provide a more  
2 sound basis for the development of a long-term monitoring and research plan. **The model will**  
3 **also contribute to prioritize activities undertaken in response to the biological opinion and**  
4 **reasonable and prudent alternative.**

5 The “working” strategic model will continue to be refined and developed over the course  
6 of the first five-year strategic plan. More detailed submodels for specific elements of the system  
7 (i.e., riparian vegetation, cultural resources, etc.) will be developed through prototypes to  
8 operational stages.

## 9 **THE PHYSICAL RESOURCES PROGRAM**

10 The focus of the physical resource program is primarily on physical processes related to  
11 water and sediment resources, and how they act independently and together upon other resources  
12 under **differing the range of dam operations described in the preferred alternative.** Much of the  
13 monitoring and research efforts focus on critical attributes of each, such as their physical  
14 properties, i.e.; water temperature, sediment structure, etc.

### 15 **The FY96 and FY97 Transition Monitoring and Research Program**

16 The FY96 and FY97 transition monitoring and research program activities were, in large  
17 part, an extension of activities established in the 1990-1995 period. Projects ongoing since  
18 October 1, 1995 and planned to continue until October 1, 1997 include the following:

- 19 • Determine the processes of rapid erosion and the effects on evolution and longevity  
20 of channel margin deposits.
- 21 • An Assessment of dam operation impacts on Lake Powell Water Quality.

- 1 • Maintenance of database containing unit values associated with streamflow gaging  
2 network throughout the Grand Canyon.
- 3 • Monitoring flow and sediment inputs from Paria and Little Colorado Rivers.
- 4 • Measurement and processing of data from monumented cross sections.
- 5 • Computation of volumes of sand-storage changes within eddy complexes and in the  
6 main channel.
- 7 • Completion of report on sand-transport algorithm for Colorado River above Little  
8 Colorado River.
- 9 • Completion of report on changes in bed materials through resurvey of selected  
10 reaches.
- 11 • Evaluation of backwater rejuvenation associated with the Beach/Habitat-Building  
12 Flow of 1996.
- 13 • Continuation of the monitoring of sand bars and camping beaches along the  
14 Colorado River; includes maintenance of the ~~daily~~ photographic records and sand bar  
15 surveying.
- 16 • Integration and evaluation of Phase II Glen Canyon Environmental Studies Research  
17 Findings: Biological and chemical components of Grand Canyon riverine  
18 ecosystem.
- 19 • Integration of the Glen Canyon Environmental Studies Research Findings: Sediment  
20 transport and geomorphology.

1 Evaluations of the above components of the FY96 and FY97 programs reveal that the  
2 following research studies which are scheduled to end October 1, 1997 should be terminated and  
3 selected components restructure for FY98, and selected components restructured for FY98.

- 4 • Determine the processes of rapid erosion and the effects on evolution and longevity  
5 of channel margin deposits.
- 6 • An Assessment of dam operations impacts on Lake Powell Water Quality.
- 7 • Completion of report on sand-transport algorithm for Colorado River above Little  
8 Colorado River.
- 9 • Completion of report on bed materials and resurvey of selected reaches.
- 10 • Evaluation of backwater rejuvenation along the Colorado River in Grand Canyon,  
11 AZ.
- 12 • Integration and evaluation of Phase II Glen Canyon Environmental Studies Research  
13 Findings: Biological and chemical components of Grand Canyon riverine  
14 ecosystem.
- 15 • Integration of the Phase II Glen Canyon Environmental Studies Research Findings:  
16 Sediment transport and geomorphology.

17 These research/inventory projects provided timely and needed input to both the scientific  
18 and management community, as noted above. Monies allocated to these projects will be moved  
19 to new and revised physical resource projects that provide synthesis in these and other needed  
20 areas.

1           Several areas of monitoring and one inventory project were included in the FY96 and  
2 FY97 programs and need to be evaluated for the manner in which they will be continued in  
3 FY98. These include the following:

- 4           • Maintenance of database of unit values on streamflow gaging network throughout  
5           the Grand Canyon.
- 6           • Monitoring flow and sediment inputs from Paria and Little Colorado Rivers and  
7           ungaged drainage basins.
- 8           • Measurement and processing of data from monumented cross sections.
- 9           • Computation of volumes of sand-storage changes in the main channel.
- 10          • Monitoring of sand bars along the Colorado River - includes maintenance of the  
11          daily photographic records and sand bar surveying.

12           Maintenance of a database on unit value stream flow data is important to monitoring  
13 long-term assessments of water and sediment flux throughout the Canyon to achieve a more  
14 robust sediment balance. However, new protocols need to be investigated.

15           The existing monitoring system is proposed as a control for the next two years. A  
16 significant budget reduction is proposed for this effort. A request for proposals (RFP) will be  
17 released to determine how budget reductions will be accommodated while maintaining current  
18 levels or a significant percentage of traditional water flux monitoring.

19           The above savings will be used to conduct a synthesis of all water and sediment flux  
20 knowledge for the canyon and development and piloting of new monitoring designs that will be  
21 used on control reaches and other reaches over the next two project years. New procedures must

1 provide acceptable levels of information needs and accuracy, be less intrusive, provide greater  
2 information for resource linkage, and be more cost effective.

3 Four areas of monitoring and one survey program addressed sediment flux in the canyon  
4 in FY96 and FY97 . These efforts track suspended sediment, sediment dynamics, and sediment  
5 deposition. The research program used to evaluate sandbar changes is only indirectly linked to  
6 other monitoring efforts and needs to be directly linked.

7 The total budget for the four monitoring and one research project will be reduced  
8 significantly from FY97 funding. In FY98, a request for proposals will be released to merge all  
9 of these efforts into one project that :

- 10 1. Maintains information needs and accuracy.
- 11 2. Improves cross linkage needs to other resources.
- 12 3. Has less site intrusive protocol.
- 13 4. Is less expensive.

#### 14 **Responding To Information Needs**

15 The information needs specified for the FY98 Physical Resources Program is presented  
16 in the following synopsis.

#### 17 **Water Resources**

- 18 • Monitor changes in the physical and chemical characteristics of water over time.
- 19 • Monitor concentrations of chemical constituents with established EPA/state and  
20 Tribal standards.
- 21 • Maintain database on unit values for streamflow.
- 22 • Measure water composition and temperature and their changes over time.

- 1           • Monitor flow regime relationships to sediment.

2           **Sediment Resources**

- 3           • Characterize terrace, sand-bar, backwaters, and return channel target structures.
- 4           • Define target backwater ecosystems and associated flow regimes.
- 5           • Define character and structure of terraces with cultural properties and of all beaches
- 6           and backwaters in system after 1996 test flows.
- 7           • Define historical and current levels of river stored sediment (character and structure)
- 8           in system and associated flow regimes.
- 9           • Determine baseline conditions.

10          **The FY98 Physical Resource Program**

11           The FY98 Physical Resources Program structure is developed to respond to the Strategic

12          Plan, which is structured around objectives and information needs of stakeholders. The

13          Strategic Plan, and this Annual Plan addresses information needs in four areas:

- 14           • Dam discharge and water flux in system.
- 15           • Sediment flux in system.
- 16           • Tributary interaction with mainstem resources.
- 17           • Mainstem water and sediment flux impacts to Lake Mead delta.

18           Dam discharge and water monitoring and research will continue in FY1998 ~~FY98~~ with the

19          following projects:

- 20           • Capturing unit values of dam discharge and streamflow through the Grand Canyon
- 21           (Lees Ferry, Grand Canyon, Diamond Creek) and LCR and Paria Rivers using

1 traditional monitoring and research approaches of FY96 and FY97. (Funding levels  
2 will be significantly reduced from FY97 levels).

- 3 • Synthesis of all past monitoring of dam discharge and water flux in Grand Canyon,  
4 and development and pilot test of new protocols for water flux monitoring.

5 Sediment flux monitoring and research will focus on synthesis of past efforts, developing  
6 improved monitoring methodology and development of linkages to other resources. Individual  
7 projects are as follows.

- 8 • A synthesis of all past sediment flux research in the Grand Canyon with the  
9 objectives of development of attribute associations between sediment flux and flow  
10 regimes, including upper terrace deposits with cultural materials.
- 11 • A synthesis of all historical information (pre and post dam) related to sandbar  
12 dynamics. Develop associations of flow regimes and bar formation and degradation.
- 13 • A synthesis of all science and information (pre and post dam) related to sediment  
14 balance in the riverine system by geomorphic reach. Focus is on integrating  
15 information on bars, flux and storage to provide a method for determining sediment  
16 balance and evaluating headwall cutting impacts to upper terrace cultural resources.
- 17 • Continue the sediment monitoring of FY97 (sandbars, cross sections, etc.).  
18 However, merge all monitoring into a smaller number of projects, eliminating  
19 duplication, and establishing protocols so as to provide best time and space  
20 assessments of parameters in a given reach. Also, merge efforts in research and  
21 mapping assessments into this new more comprehensive sediment monitoring

1 approach, and link to camping area monitoring in socioeconomic program and  
2 cultural resources monitoring in the cultural resources program.

- 3 • Develop a new sediment monitoring protocol by geomorphic reach that relates all  
4 mainstem channel dynamics related to sediment and flow. The intent of the new  
5 protocol is to develop base information for developing future algorithms and  
6 associated information to evaluate changes in sediment balance by reach through  
7 time.

8 Tributary impacts and sediment interaction on mainstem resources is an area where  
9 considerable knowledge needs to be generated regarding water quality, sediment flux and  
10 nutrient levels. Following are FY98 proposed projects.

- 11 • Develop a new sediment monitoring protocol by reach from Glen Canyon Dam to  
12 upper Lake Mead that relates mainstem channel dynamics to sediment and flow.
- 13 • Synthesis of all research and monitoring of marsh, back channel, backwater and  
14 Mainstem flows and sediment below tributary confluence and their relationships to  
15 tributary water and sediment flux dynamics at differing dam operations.
- 16 • Synthesis of information associating sediment nutrient level in reaches below  
17 tributaries to variable flow regimes.
- 18 • Maintenance of a database on unit value monitoring protocols for LCR and Paria, but  
19 at reduced budget levels.
- 20 • Development of new monitoring protocols for at least two side channels, LCR and  
21 Paria and pilot new protocol.



1 cultural resources identified during field inventories by the agencies and the Native American  
2 tribes. Monitoring techniques include photographic documentation, instrument mapping, and  
3 testing of culture resources that are currently deteriorating. The PA activities for FY96 and FY97  
4 have been approved and funded by the BOR. Ongoing projects since October 1, 1995 through  
5 September 30, 1997 include: 1) archaeological monitoring in the Glen and Grand Canyon areas  
6 by the NPS; 2) Hualapai and Southern Paiute Consortium ethnobotanical monitoring; and 3)  
7 cultural resource monitoring by the Hopi, Hualapai, Navajo, Southern Paiute Consortium and  
8 Zuni tribes. These activities are required under the PA program and need to be continued.

9 At the request of the PA parties, that are members of the AMWG, PA activities  
10 proposed for FY98 may be included within the GCMRC annual plan. Requests from these PA  
11 parties will be directed through the AMWG process to become part of the GCMRC directives.  
12 PA activities that are not included within the GCMRC program, remain the responsibility of the  
13 BOR/NPS as they are legal PA requirements of those agencies. Funding recommendations by  
14 the AMWG pertain only to GCMRC activities as the AMWG has no authority concerning the PA  
15 program. At the present time, activities that will be channelled by the PA parties into the  
16 AMWG process have not been specified for FY98. However, it is anticipated that some of the  
17 activities currently being undertaken will be proposed and incorporated into the FY98 Annual  
18 Plan.

### 19 **Stakeholder Objectives and Information Needs**

20 Several objectives and information needs have been identified by stakeholders for cultural  
21 resources. The stakeholder objectives include: 1) Preserve *in situ* all the downstream cultural  
22 resources and take into account Native American cultural resources concerns in the Colorado

1 River corridor; 2) If *in situ* preservation is not possible, design mitigative strategies that integrate  
2 the full consideration of the values of all concerned tribes with scientific approach; 3) For  
3 participating Native American tribes, protect and provide physical access to cultural resource  
4 properties for religious purposes within the river corridor; and 4) Develop appropriate research  
5 strategies which maximize data collection from mitigation and monitoring efforts for  
6 understanding human use and occupation in the canyon.

#### 7 Specified Information Needs Addressed in FY98 Annual Plan

8 Information needs have been identified by the stakeholders to address the above  
9 objectives. Portions of many of the information needs are addressed in the proposed activities for  
10 this FY98 annual plan. The information needs that are included within this plan are:

11 1) Develop data and monitoring systems to assess impacts; 2) Develop data to assess risk of  
12 damage, critical threshold levels, and loss from varying flow regimes; 3) Develop tribal  
13 monitoring programs for the evaluation of impacts to cultural resources; 4) Test and apply  
14 geomorphic model relative to archaeological site erosion; 5) Design and develop integrated  
15 relational data systems to support management and research program goals; 6) Develop  
16 technology / procedures for providing relevant/ protected data to appropriate groups/tribes; and  
17 7) Ensure confidentiality of data regarding location of cultural sites.

#### 18 Specified Information Needs Not Addressed in FY98 Annual Plan

19 Some information needs are not included in the FY98 annual plan. Activities that address  
20 the needs not included in this plan will be scheduled in the following years because  
21 implementation is contingent upon information generated from other activities. These  
22 information needs include: 1) Development of mitigation strategies related to the broad

1 spectrum of cultural resources included within the GCMRC program and identified by  
2 monitoring assessments, and 2) Characterize resources through scientific (research) study.

### 3 **FY98 Cultural Resources Monitoring and Research Activities**

4 Four activity areas are proposed for the FY98 Annual Plan. These activities respond to  
5 the information needs identified by stakeholders and the Strategic Plan developed by the  
6 GCMRC and stakeholders. These activities form the basis for projects that may be proposed in  
7 subsequent years. A fifth activity area is specified to accommodate projects that may be directed  
8 into the GCMRC cultural program from the PA program by the PA signatories that are members  
9 of the AMWG.

#### 10 1. Synthesize existing data

11 Monitoring data has been collected on cultural resources by the NPS for several years.  
12 As a result of the GCDEIS process, monitoring activities were increased and became more  
13 standardized. This information was synthesized to provide direction for activities in the PA  
14 program. Since the cultural resource survey in 1991, the NPS and tribal groups have continued  
15 to monitor resources several times a year under the stipulations of the PA program. In part, this  
16 information has been partitioned into areas where different entities have jurisdiction. The  
17 information gathered during PA monitoring activities needs to be compiled into the GCMRC's  
18 study area and synthesized. Baseline information needs to be reviewed to ensure that sufficient  
19 data exist for all sites having the potential of sustaining dam operational impacts. The existing  
20 monitoring data need to be synthesized and evaluated against baseline information. Some of the  
21 possible elements of the data organization include site location and physical context; site types  
22 (e.g., structures, features, scatters, prehistoric, historic, Traditional Cultural Properties (TCPs),

1 rock art sites); monitoring frequency; monitoring techniques; monitoring history; etc. Data on  
2 isolated occurrences (Ios) also needs to be synthesized. Ios may represent the last remains of site  
3 materials, or they may constitute the first exposures of buried sites. IO data need to be analyzed  
4 to understand site formation (and degradation) processes relative to dam operations.

5 This synthesis is also required under the PA program and the PA signatories, who are  
6 members of the AMWG, may request that the GCMRC cultural program undertake this activity.  
7 If so, this effort would represent an activity that would serve complementary purposes for both  
8 programs.

## 9 2. Develop a risk assessment for cultural resources from varying flow regimes

10 The objective of these efforts is to understand the potential risks to cultural resources  
11 from: A) various flow stages, and B) the related erosional processes and their impacts to the  
12 resources. Although some resource impacts are known from the 1996 Beach/Habitat-Building  
13 Test Flow, other flow stages can be modeled to predict possible impacts from future planned or  
14 unplanned releases. Some examples of these impacts include inundation of resources, and bank  
15 failure and cutbank retreat resulting in erosion of upper terrace sediments with archaeological  
16 deposits. Development of a stage-to-discharge relationship at selected resource locations will  
17 help to determine inundation frequency as well as critical threshold levels for triggering  
18 recommendations for remedial responses.

19 The existing work linking certain geomorphic processes and archaeological site erosion  
20 needs to be evaluated. This work hypothesizes that sediment loss related to certain flow levels  
21 fosters arroyo cutting through upper terraces, mainstem bank failure, and cutbank retreat. These  
22 processes remove terrace sediments that contain archaeological deposits. Past site assessments

1 from PA program field work, indicates that additional archaeological site monitoring needs to  
2 occur to test the above hypothesis.

3 Finally, the ability of high flows to stabilize predam terrace deposits needs to be  
4 investigated. These objectives can be accomplished through the monitoring of the Beach/Habitat-  
5 Building Flow deposits where archaeological resources have been previously mapped.

6 3. Develop tribal programs to assess resource impacts

7 Tribal cultural programs are an important component of the GCMRC resource  
8 assessments. These programs supply different information on resource impacts that complement  
9 conventional assessments; they help to provide information on the full range of important  
10 qualities of the resource and they span GCMRC program areas. Tribal programs also provide  
11 important technical information about a group's past and present resources.

12 Although specific tribal proposals for FY98 have not been developed as yet, the GCMRC  
13 proposes efforts in three areas. These include: 1) a resource assessment with the Hualapai Tribe  
14 that addresses ethnobotanical resources and resource management across tribal land that will be  
15 co-funded by the GCMRC (when consistent with GCMRC protocols) and by an outside  
16 foundation; 2) a tribal GIS resource mapping project that will incorporate general areas of  
17 resource concerns and facilitate consultation with tribal groups; and 3) a student intern program  
18 that will utilize students from participating Native American tribes to conduct necessary studies  
19 and activities is also desirable.

20 4. Develop appropriate data systems and related technology

21 Cultural resource data require systems and technology that address the confidential and  
22 restricted nature of the information. The GCMRC proposes to develop data systems and

1 technology that support management and research program goals while providing relevant, but  
2 sensitive, data to the appropriate tribe. In order to achieve these objectives, the GCMRC  
3 proposes to develop protocols with tribal representatives concerning sensitive and confidential  
4 data. Protocols will be developed in a series of workshops that address tribal and agency  
5 concerns for the appropriate treatment and storage of sensitive data. Preliminary efforts to  
6 address data concerns will begin in late Spring, 1997.

7 5. Accommodation of PA program activities.

8 At the request of PA parties, that are members of the AMWG, PA activities may be  
9 included in the FY98 GCMRC Annual Plan. Presently, these activities have not been specified  
10 for FY98, however, it is anticipated that some of these activities will be proposed and  
11 incorporated into the Plan.

12 **THE BIOLOGICAL RESOURCES PROGRAM**

13 **Introduction**

14 The synthesis, inventory, monitoring and research activities proposed for biological  
15 resources is intended to develop and maintain critical data streams relating to the structure and  
16 function of the Colorado River ecosystem in Glen and Grand Canyons (the ecosystem), as well as  
17 "... the effects of the Secretary's actions..." on the ecosystem. The effort will improve the  
18 knowledge base required to implement ecosystem management strategies within an adaptive  
19 management framework.

20 The development of a fundamental information base on the structure (components) and  
21 function (processes) of the ecosystem is a prerequisite to prediction of ecosystem effects. It is  
22 key that relationships between the biotic and abiotic components of the ecosystem be addressed,

1 for without an understanding of these relationships, no predictive capability exists to evaluate the  
2 "...effects of the Secretary's actions..." on critical biological resources and the Colorado River  
3 ecosystem in general.

4 **The FY96 and FY97 Biological Resources Transition Monitoring Program**

5 Monitoring and research studies initiated in FY96, as part of the experimental flood have  
6 been continued with minor modifications in funding for FY97. Studies being conducted in  
7 FY97 are listed below.

<b>FY97 MONITORING AND RESEARCH ACTIVITIES</b>	
<b>I.</b>	<b>AQUATIC FOOD BASE</b>
	<ul style="list-style-type: none"> <li>Monitor the effects of flows on the aquatic food base in the Colorado River downstream from Glen Canyon Dam. Includes determination of the standing crop of algae and invertebrates, as well as species composition and drift of algae and invertebrates.</li> </ul>
<b>II.</b>	<b>FISH (NATIVE AND NON-NATIVE)</b>
	<ul style="list-style-type: none"> <li>Monitoring and research, including sampling backwaters, mainstem, nearshore and tributary mouth habitats to assess fishery resources and habitats in Glen and Grand Canyons.</li> <li>Standardized hoop net monitoring of humpback chub spawning population in the lower 1200 m of the Little Colorado River.</li> <li>Monitoring the status of the trout fishery in the Lees Ferry area and evaluate current sampling programs and protocols.</li> <li>Backwater temperature and rejuvenation and marsh destruction studies</li> </ul>
<b>III.</b>	<b>RIPARIAN VEGETATION</b>
	<ul style="list-style-type: none"> <li>Transition monitoring of riparian plants and habitats in Glen Canyon National Recreation Area and Grand Canyon National Park.</li> <li>Coordination of the riparian vegetation studies in the lower Grand Canyon corridor below National Canyon to Lake Mead.</li> </ul>
<b>IV.</b>	<b>NATIVE TERRESTRIAL WILDLIFE RESOURCES AND HABITAT</b>
	<ul style="list-style-type: none"> <li>Monitoring of riparian birds along the Colorado River from Glen Canyon Dam to Lake Mead.</li> </ul>
<b>V.</b>	<b>ENDANGERED AND OTHER SPECIAL STATUS SPECIES</b>
	<ul style="list-style-type: none"> <li>Monitoring southwestern willow flycatchers along the Colorado River corridor.</li> <li>Coordinate and monitor the impacts of the Beach/Habitat-Building Flow on the endangered Kanab ambersnail at Vasey's Paradise, and evaluate population recovery.</li> <li>Studies related to implementation of the Glen Canyon Dam Biological Opinion.</li> </ul>
<b>VI.</b>	<b>SYNTHESIS AND INTEGRATION</b>
	<ul style="list-style-type: none"> <li>Integration and evaluation of Glen Canyon Environmental Studies research findings related to biological and chemical components of the Grand Canyon riverine ecosystem.</li> <li>Integration and synthesis of information on endangered and other native fish in Glen and Grand Canyons.</li> </ul>

1           These monitoring and research studies provide timely and needed input to both the  
2 scientific and management community. Draft reports on the FY96 activities have only recently  
3 been received and are currently being reviewed for their contribution to the goals and objectives  
4 described in the GCMRC Strategic Plan. As noted above, with minor modifications in funding,  
5 these activities have been continued in FY97 . Activities scheduled to be completed in FY97  
6 will be reviewed regarding decisions on whether or not to continue those activities. Monies  
7 associated with monitoring and research activities which are terminated will be reallocated to  
8 conceptual modeling, synthesis, and new monitoring and research activities.

9           The Biological Resources Program intends to award its FY98 monitoring and research  
10 studies through a competitive request for proposals process, as discussed in the Strategic Plan.

### 11   **Responding to Stakeholder Objectives and Information Needs**

12           As described in Chapter 2, consultation with stakeholders led to the development of a set  
13 of stakeholder objectives and corresponding stakeholder information needs. Subsequent  
14 meetings with scientists stepped the stakeholder information needs down into a knowledge base  
15 (i.e., scientists' knowledge and scientists' need to know), and potential elements of a monitoring  
16 and research program (i.e., scientists' monitoring statements and scientists' research questions).  
17 The FY98 biological resources program is based on (1) the GCMRC Strategic Plan, which calls  
18 for an emphasis on synthesis activities and the development of a conceptual systems model, and  
19 (2) the stakeholder objectives and information needs.

1     **The FY98 Biological Resources Program**

2             The FY98 program will consist of synthesis, monitoring and research activities. These  
3 include aspects associated with the aquatic food base, humpback chub and other native fish, trout  
4 and other non-native fish; riparian vegetation, and selected threatened and endangered species  
5 (i.e., Kanab ambersnail and southwestern willow flycatcher,).

6             The FY98 biological resources program will be funded at FY97 levels. The need to  
7 initiate synthesis and modeling activities within existing funding levels requires careful  
8 evaluation of FY98 monitoring and research efforts.

9             **Aquatic Food Base**

10            Many wildlife species, especially fish, depend on the aquatic food base (e.g., algae,  
11 macroinvertebrates) for their survival. Dam operations or other factors may trigger fluctuations  
12 in the aquatic food base and in turn affect population dynamics of native and non-native fish  
13 species. Recognizing the primary role played by the aquatic food base in the Colorado River  
14 ecosystem, the stakeholders have clearly stated that this resource should be maintained or  
15 enhanced.

16            Understanding the processes that enable the maintenance and/or enhancement of the  
17 aquatic food base requires synthesis and monitoring and research activities. Synthesis activities  
18 will utilize existing information, both published and unpublished, to address questions  
19 concerning trophic dynamics. Efforts will be made to understand the likely response of the  
20 aquatic food base to alternative dam operations. Special emphasis will be placed on the  
21 relationship of the aquatic food base to native and non-native fish.

1 Monitoring programs associated with the aquatic food base will run concurrent with  
2 synthesis activities. Protocols associated with monitoring need to be defined for each parameter  
3 considered for monitoring. Data for both biotic and abiotic variables (e.g., species composition,  
4 productivity, temperature, pH) that are ~~determined~~ **thought** to be critical for food base monitoring  
5 will be collected and analyzed. Monitoring efforts will emphasize areas related to:

6 1. Community structure, density and distribution of the food base in the mainstem and  
7 tributaries.

8 2. Data collections that enable distinction between the effects of dam operations and  
9 natural variation on the aquatic food base.

10 3. Linkages between nutrient levels, water quality and community structure (benthos,  
11 drift, etc.) in relation to dam operations, Lake Powell input and tributary influences.

## 12 **Fish**

13 Fish are an important part of the ecosystem because of their trophic role, their important  
14 recreational value, and because some are listed as threatened or endangered species. Changes in  
15 the structure or function of the ecosystem resulting from alternative dam operations could have  
16 either harmful or beneficial effects on fish populations. The stakeholders have identified six  
17 objectives and twenty-nine information needs related to native and non-native fish concerns.

18 **Humpback chub and other native fish.** As part of the FY97 program, a data  
19 integration project is being conducted on endangered (i.e., humpback chub) and other native  
20 fish. The main focus of this effort is to identify factors that limit reproduction, development,  
21 recruitment, or survival of these fish. The interim results of this effort (available in late  
22 February, April, 1997) will be used as the basis for deciding if additional synthesis work is

1 needed, and what types of research projects should be considered. Activities aimed at the  
2 development of protocols and procedures for maintaining, accessing, and using a PIT tag  
3 database will be part of any synthesis activities. It is hoped that this work will bring more clarity  
4 to the importance of 1) flow regimes, water temperature and clarity; tributaries, backwaters,  
5 and nearshore habitats; food availability and dietary requirements of very young fish, 2)  
6 competitive and predatory interactions with non-native fish, 3) the effects of existing and  
7 potential parasites, and 4) **assessment of humpback chub population status and trends (e.g.,**  
8 **changes in the condition of mature humpback chub and other native fish).**

9 For native fish populations to remain viable, successful recruitment must occur. The  
10 three major factors thought to influence successful fish recruitment are: hydrology and transport;  
11 food production and availability; and larval fish abundance. In general for fish, the timing of  
12 reproduction must coincide with local food production cycles, and larvae must be transported to a  
13 favorable nursery habitat for there to be successful recruitment. Food production and  
14 availability, habitat quality and availability, and competitive interactions can slow growth rates,  
15 potentially increasing the risks at young life stages, resulting in increased mortality and reduced  
16 recruitment.

17 Monitoring and research activities developed as part of the FY98 program will be aimed  
18 at understanding the links among dam operations and the resulting flow regimes and 1)  
19 spawning, larval transport, and recruitment; 2) habitat availability and use; 3) food availability  
20 and diet; and 4) competitive and predator-prey interactions with non-native fish.

21 **Trout and other non-native fish.** Trout were first introduced into tributaries of the  
22 Colorado River in Glen and Grand Canyons in the 1920s. Following the construction and

1 closure of Glen Canyon Dam in 1963, trout have become an important recreational resource in  
2 the 25 km reach below Glen Canyon Dam. This is primarily due to the high primary  
3 productivity resulting from the high water clarity, the presence of coarse substrates, increased  
4 benthic standing biomass, reduced water temperatures, and the regular stocking and management  
5 of the recreational trout fishery. Alternative dam operations and the resulting flow regime can  
6 affect the food base for trout, as well as the mortality of adult, juvenile, and larval fish through  
7 stranding, dewatering, and displacement.

8 A synthesis of existing information (both published and unpublished data) concerning the  
9 trout fishery and its likely response to alternative dam operations will be conducted. Following  
10 this synthesis, specific research needs will be developed and prioritized.

11 Monitoring activities to be undertaken as part of the FY98 program will focus on  
12 growth, survivorship, and changes in population structure, including the contribution from  
13 natural reproduction.

#### 14 **Riparian Vegetation**

15 Riparian vegetation is recognized as an important resource serving many roles in the river  
16 corridor. The vegetation stabilizes stream and river banks, provides habitat for fish and wildlife  
17 and has aesthetic and recreational value. The riparian vegetation communities along the  
18 Colorado River were changed drastically by the construction of Glen Canyon Dam. Today the  
19 riparian vegetation is composed of three distinctive communities: (1) the upper riparian zone  
20 (URZ), (2) the lower riparian zone (LRZ), and (3) the hydro-riparian wetland community. The  
21 preservation or restoration of riparian communities affected by dam operations is an objective  
22 identified by the stakeholders.

1            Synthesis and monitoring of riparian and marsh communities will occur simultaneously in  
2 FY98. Synthesis activities will emphasize community response to alternative dam operations,  
3 and interspecific interactions that occur within riparian communities. Subsequent research needs  
4 will be developed from these synthesis efforts. Monitoring efforts in FY98 will emphasize areas  
5 related to:

- 6            1. Community structure, diversity, and density of riparian and marsh vegetation. The  
7 spread and contraction of communities will be determined in conjunction with these monitoring  
8 efforts.
- 9            2. Native and non-native/invasive vegetation with respect to recruitment, spread and  
10 survivorship.
- 11           3. Habitat integrity and composition as it relates to other resources such as threatened  
12 and endangered species (e.g., southwestern willow flycatcher, Kanab ambersnail).
- 13           4. The development of linkages between vegetation, aquatic food base, and fish habitat.

#### 14           **Avifauna**

15           Consistent with stakeholder objectives and information needs and building upon ongoing  
16 studies, limited and focused avifauna monitoring and research activities will be considered as  
17 part of the FY98 program. These will focus on the southwestern willow flycatcher and general  
18 riparian avifauna.

19           With respect to the southwestern willow flycatcher, efforts will focus on the status of the  
20 nesting population and the dynamic nature of its colonizing behavior. Regarding general riparian  
21 avifauna, activities that can contribute to the development of baseline population estimates,  
22 taking into account natural variation, and the effects of habitat alteration and competitive

1 interactions on wintering and breeding waterfowl, riparian obligate species, resident non-obligate  
2 species, and migrant species will be considered.

### 3 **Special Status Species**

4 The stakeholders have recognized in their objectives the importance of native and other  
5 special status plant and animal species. Specifically, they have called attention to the Kanab  
6 ambersnail and the southwestern willow flycatcher. They have called for information which will  
7 help protect, restore, or enhance the survival of special status species. In the case of the Kanab  
8 ambersnail, specific activities will be focused on addressing the requirements of the Biological  
9 Opinion, and Recovery Plan as appropriate. This includes a focus on appropriate age-class  
10 distributions, food availability, and habitat needed to ensure the sustainability of these  
11 populations.

12 The stakeholders also identified, as important, work related to the reasonable and prudent  
13 alternative and Biological Opinion. Following consultation with the U.S. Fish and Wildlife  
14 Service and the Bureau of Reclamation, GCMRC will evaluate how its proposed FY98 activities  
15 relate to the reasonable and prudent alternative and the biological opinion. Where needed,  
16 appropriate revisions will be proposed.

### 17 **Other studies**

18 Given the limited amount of funds available for the FY98 program little work is  
19 anticipated on the remaining stakeholder objectives. Other related studies, proposed, and funded  
20 and conducted outside GCMRC programs will be encouraged, as appropriate. Limited scoping  
21 studies to better define appropriate monitoring and research activities may be considered for  
22 terrestrial invertebrates and non-avian vertebrates..

## 1     **The Contribution of the FY98 Program to the Strategic Plan**

2             The FY98 program is clearly linked to the stakeholder objectives and information needs.  
3     The information gained from the proposed synthesis, monitoring, and research activities when  
4     combined with the results of the conceptual modeling effort will make significant contributions  
5     to our understanding of the key components and processes that structure the Colorado River  
6     ecosystem in Glen and Grand Canyons. This information is likely to result in significant  
7     revisions and improvements to the development of the long-term monitoring and research plan.  
8     It is anticipated that further pilot monitoring activities will be initiated in FY99 resulting in the  
9     development of a conceptual systems model, and associated synthesis and research activities, a  
10    sound long-term monitoring and research program can be in place by FY2000.

## 11                   **THE SOCIO-ECONOMIC RESOURCES PROGRAM**

12            There are many socio-economic resources associated with the Grand Canyon riverine  
13    environment including recreation (i.e., boating, fishing, hiking, sightseeing), electric power, and  
14    water storage and delivery. Further, due to the biological and geologic distinctiveness of the  
15    Colorado River corridor, the ~~region~~ Grand Canyon ~~National Park~~ ~~the park~~ has acquired national  
16    and international recognition, and all of the resources in the canyon are considered to be  
17    significant to the public.

18            The FY96 and FY97 socio-economic resources program was reduced from the FY94 and  
19    FY95 program, where studies were undertaken to evaluate significant effort occurred on  
20    evaluating non-market impacts of alternative dam operations. Although several projects in other  
21    resource areas have linkages to socioeconomic parameters and resources, (i.e., trout, sandbars,

1 birds) only two projects were specifically oriented to socioeconomic assessments of alternative  
2 dam operations as follows:

- 3 • Transition monitoring of riparian plant beach invasions and beach habitat building in  
4 Grand Canyon National Park.
- 5 • Beach ~~campsite~~ camping area changes resulting from the beach habitat building  
6 flow.

7 Both of these projects relate to changes in recreation benefits resulting from a modified  
8 flow regimes. Both projects will be completed are scheduled for completion in FY97. and will  
9 be terminated. However, after a synthesis effort in FY98, the socio-economic program  
10 including ~~campsite~~ camping beach studies will be redesigned for FY99.

11 Information needs specified for this resource area cover issues of camping, beaches, water  
12 safety, sports fishing and wildlife (waterfowl) viewing and hunting. Following are a synopsis of  
13 specified information needs.

- 14 • Determine criteria and aspects that are important to, or detract from the wilderness  
15 experience.
- 16 • Determine adequate beach quality, character and structure for camping throughout  
17 the system.
- 18 • Determine if operating criteria maintains safe and adequate powercraft navigability  
19 in Glen Canyon and upper Lake Mead.
- 20 • Determine flow regimes necessary to maintain fish populations of 100,000 adult  
21 Trout (age class II plus).
- 22 • Define pattern of waterfowl and other wildlife use and conflicts to other uses.



1 guidelines, modeling relationships, or increasing understanding of the various resources and  
2 system under study, justify an aggressive program of information acquisition, management, and  
3 evaluation.

4  
5 Information Needs have not been explicitly defined for the information technologies area.

6 However, significant needs in this area can be interpreted from the four major resource areas.

7 The FY98 information management program has, therefore been developed from identified  
8 information needs, until more explicit needs can be defined.

- 9 1. Development of protocols for data collection, processing and use.
- 10 2. Development of extensive databases across all resources and a database management  
11 system.
- 12 3. Development of a robust geographic information system to accommodate multiple  
13 layers associated with all resources of interest to stakeholders.
- 14 4. Development of databases associated with remotely sensed data, here to date not  
15 incorporated in the GCES database system.
- 16 5. Stakeholder direct access to selected data and information in the database  
17 management system and GIS.
- 18 6. Development of outreach programs to transport data and information to stakeholders.
- 19 7. Maintain database of unit value streamflows.

20 FY98 Information Technologies have been defined for four areas: database management  
21 systems, GIS, increasing stakeholder access to data and technology, and outreach programs. A  
22 general principle for database management is that all data will be freely available.

1 To ensure critical access to developed data, scientists will be expected to provide their  
2 data to GCMRC after a reasonable period (e.g., one year) of exclusive use. However, in some  
3 cases, such as archaeological-site data, data that Indian Tribes define as sensitive, or information  
4 on localized endangered species, a level of confidentiality will be necessary. Explicit protocols  
5 will be developed to ensure this confidentiality. Specific projects proposed are:

- 6 • Revise/develop Meta-data protocols and DBMS protocols to expand current system  
7 capability and protect existing data base.
- 8 • A centralized, integrated database will be developed to facilitate exchange of  
9 information among projects. However, significant portions of the system will be  
10 distributed.
- 11 • Protocols will be developed to cross-reference files from centralized to distributed  
12 systems.
- 13 • Develop direct access to DBMS for managers/stakeholders.

14 Geographic Information Systems (GIS) will be used for data storage analysis and data  
15 transfer to users. In FY98 several efforts are proposed.

- 16 • Revision of GIS protocols to expand system.
- 17 • Movement of priority information needs into GIS where appropriate.
- 18 • Develop GIS access for managers/stakeholders .

19 Several primary information technology thrusts are planned to give greater information  
20 access to stakeholders.

- 21 • Develop home page access for stakeholders.

- 1       • Develop and implement programs for direct access and use of GCMRC Lake Powell
- 2       data and Colorado River water and sediment flux data.
- 3       • Develop and implement a training program for stakeholders on the GCMRC DBMS.
- 4       • Develop and implement a training program for stakeholders on ARC view for
- 5       existing GIS data.
- 6       • Maintain unit value data stream archives beyond the time availability associated with
- 7       the present USGS system.

## CHAPTER 4

### PROGRAM ADMINISTRATION

### ORGANIZATION STRUCTURE

The GCMRC is restructuring to accommodate the challenges of both the Strategic Plan and the FY1998 Annual Plan. Three program managers (physical, biological, and cultural) will manage the individual resource areas and together with the chief focus on evaluation of ecosystem resource interactions and integration under differing dam operations. An information technologies director will oversee an extensive program of data analysis and management, GIS technology and transfer.

Positions that will be critical to stakeholders are defined in the following text as to their primary roles.

Logistics Coordinator. The GCMRC has decided to conduct all logistics for its programs internally in FY98 and FY99, with direct coordination with appropriate NPS offices. This effort will reduce logistics costs by 30%. All river trip logistics and permitting, air photography, rescue, etc, will be programmed by the logistics coordinator in cooperation with the NPS. An annual logistics plan will be drafted, incorporating joint GCMRC/NPS workshops for principal investigators, and published guidelines for permitting and reporting.

Review Coordinator. All competed proposals, PI reports, GCMRC reports, cooperative programs, etc. will be subjected to specific independent review protocols of the GCMRC. Monitoring and research projects to be subjected to competitive reviews and awards will be

1 specified each year in the Annual Program Plan. This program, under the associate center chief  
2 will be managed by a coordinator. The coordinator can be contacted by PIs and/or their  
3 organizations, managers and other stakeholders to access critical documents detailing GCMRC  
4 programs.

5 A Programmatic Agreement Task Group Is proposed to facilitate the articulation between  
6 the Cultural Resource Program and the Programmatic Agreement program. The Task Group will  
7 consist of the GCMRC Cultural Program Manager, BOR and NPS managers, and tribal  
8 representatives.

9 A Biological Opinion Task Group will be linked to the Biological Resources Program  
10 Managers office. It will assure GCMRC responds, as appropriate, to the monitoring and  
11 research needs of the BOR and USFWS. The Task Group will consist of the GCMRC Biological  
12 Resources Program Manager and appropriate representatives of BOR and FWS. All proposed  
13 activities will be reviewed by the AMWG.

14 Coordinators will be specified for Data Base Management, GIS and Technology Transfer  
15 programs. These positions will assure critical timely support to managers and other stakeholders  
16 in their interactions with the GCMRC, especially in their requests for information.

17 Although GCMRC will not utilize a senior scientist position after FY97, it will select a  
18 Science Advisory Board. A group of six to eight prominent scientists will be selected to provide  
19 guidance to the center on long-term and annual plans, program structure and information  
20 technology. The group will meet at least twice a year with GCMRC staff to provide council on  
21 overall program direction.

## PROGRAM SCHEDULE

The schedule for implementation of the FY98 Annual Plan is as follows:

1		
2		
3	May 15, 1997	Release of RFPs
4	July 1, 1997	Receipt of Proposals
5	August 1, 1997	Award of Proposals
6		Release of Logistics Plan for FY1998 program
7	September 1, 1997	Approval of NPS Permits
8	April 1, 1998	First Progress Report due
9	July 1, 1998	Second Progress Report due
10	September 1, 1998	Final Draft Report due
11	October 1, 1998	Final Report due with all contract deliverables

12 All research proposed by GCMRC program managers and scientists with annual  
 13 salary/operating expenses greater than \$20,000 will also require external review and will be  
 14 included in the Annual Plan. Such projects, if one year in nature, will also conform to the above  
 15 reporting schedule.

1 **BUDGET**

2 The FY98 budget for the Adaptive Management Program was proposed in the 1996 BOR  
 3 budget process at approximately \$6.9 million. The GCMRC ~~feels~~ anticipates the budget level  
 4 will accommodate the FY98 Annual Plan, if the plan is approved without significant changes.

5 Following are the tentative budget allocations toward the FY98 Adaptive Management  
 6 Program.

	<u>000 of \$</u>
7	
8 • BOR Administration of AMP	350
9 • Overhead Services BOR	350
10 • Overhead Services USGS	220
11 • Personnel (PFT, term, contract)	1,200
12 • Information Technologies	425
13 • Logistics	450
14 • Operations	500
15 • Biological Resources Science	1,300
16 • Physical Resources Science	950
17 • Cultural Resources Science	1,100
18 • Socioeconomic Resource Science	<u>250</u>
19	
20	\$7,095,000