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Presentation of the

Long-term Monitoring and Research Strategic Plan

to the

Planning Group

by

L. David Garrett
Ruth E. Lambert
Barry D. Gold
[GCA RC/DUI]

January 8, 1997
Phoenix, AZ

GLEN CANYON ENVIRONMENTAL
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Long-term Monitoring and Research Strategic Plan

Outline of Presentation

I. Introduction **15 minutes**
- Adaptive Management
- RFPs and Peer Review
- GCMRC Science Advisory Board (SAB)
- Monitoring and Research
- Geographic and Institutional Scope

II. Approach to developing the plan **45 minutes**
- Approach adopted by GCMRC
- Management Objectives & Information Needs
- Review of past monitoring activities
- Conceptual Modeling
- Synthesis
- Pilot Monitoring Activities

III. Individual Programs **60 minutes**
- Physical Resources
- Cultural Resources
- Biological Resources
- Socio-economic Resources
- Information Technologies

I. Introduction

15 minutes

ADAPTIVE MANAGEMENT

Attributes

Iterative process;

Treats management actions as experiments subject to modification, rather than as fixed and final rulings;

Uses the management actions/experiments to develop an enhanced scientific understanding about whether or not and how the ecosystem responds to specific management actions;

Uniqueness of adaptive management approach is not simply the existence of a feedback loop between the management action and outcome, but rather the use of an explicit experimental design, that has the appropriate controls and statistical power required to determine if the management action did in fact have the desired (predicted) effect.

An adaptive policy is one that is designed from the outset to test clearly formulated hypotheses about the behavior of an ecosystem being changed by human use. In most cases these hypotheses are predictions about how one or more important species will respond to management actions. **(Lee 1993)**

ADAPTIVE MANAGEMENT

Process

Begins with the definition by stakeholders of a series of management objectives;

Management actions based on current "state-of-the-science" are implemented as "experiments" to achieve the stated management objectives;

Monitoring is undertaken to see if the ecosystem responds as predicted;

A research program, coupled to the monitoring program is implemented to discern the nature of the cause and effect relationship identified by the monitoring program;

Learning occurs as a result of the monitoring and research activities;

Future management actions are revised based on the new knowledge that has been acquired.

Reliable knowledge comes from two procedures: controls and replication. A control matches what one is changing (the treatment) to a companion case in which that same factor is left unchanged (the control). The use of controls permits insight into whether it is the treatment that is causing the effect one sees, rather than something else such as a change in the weather. Replication is essential because if knowledge is reliable it can be shown to work more than once; real relationships between cause and effect will show up consistently. **(Lee 1993)**

RFPs AND PEER-REVIEW

GCMRC long-term monitoring and research program will be implemented through a competitive peer-reviewed process.

Following approval of the long-term monitoring and research program, a request for proposals (RFP) will be issued.

Proposals will be screened by the program managers for their responsiveness to the RFP and all qualified proposals will undergo an independent and objective scientific peer-review.

Based on the results of the peer-review awards will be made.

SOLE SOURCE AWARDS
AND
INDEPENDENT PEER-REVIEWS

In some cases, especially during the transition period (FY 98 & 99), it may make sense to continue existing activities and not to hold a complete and open competition.

In the event, that a decision is made to continue an existing activity without a recompetition, the program manager will be responsible for convening an independent and objective scientific peer-review of the activity.

No funding decision will be made until such a review has been completed and the peer reviewers comments have been addressed.

GCMRC PEER REVIEW

GCMRC peer-review guidelines are currently being drafted.

GCMRC peer-review guidelines will be consistent with the "U.S. Department of Interior Guidelines for Scientific Peer Review of Research" issued by the Secretary of Interior.

GCMRC peer-review guidelines will adhere to the following principles:

-- objectivity and impartiality of reviews

-- reviews will be conducted by true scientific peers, as judged by demonstrable scientific achievements

-- independence of peer reviewers

-- provision of constructive feedback to the investigators

-- anonymity of peer-reviewers, unless waived

-- periodic evaluation of the effectiveness of the peer review process

GCMRC SCIENCE ADVISORY BOARD

GCMRC proposes to establish an independent Scientific Advisory Board (SAB) to:

-- ensure that the long-term monitoring and research program initiated by GCMRC is unbiased and objective, scientifically sound, and focused on the most important issues;

-- provide advice on the coordination and planning of the long-term monitoring and research program; and

-- annually review the results of the long-term monitoring and research program.

The SAB will be an advisory and not a decision-making body, but both the GCMRC and the AMWG should be prepared to explain why it has accepted or rejected advice provided by the SAB.

GCMRC SCIENCE ADVISORY BOARD

Membership

The SAB will be an interdisciplinary board, composed of scientists who are qualified, based on their record of publication in the peer-reviewed literature, or other demonstrable scientific achievements.

Scientists will be selected for their expertise and not as representatives of a particular agency, organization, or other stakeholder group.

GCMRC will solicit nominations and prepare a roster of members for review by the AMWG.

Members will be selected for a three-year term, renewable for one consecutive three-year term.

Initial members of the SAB will be selected for staggered one, two, and three year terms, to ensure continuity in membership on the Board.

MONITORING AND RESEARCH

Definitions

Inventorying is the measurement of environmental attributes at a given point in time to determine what is there.

Monitoring is the measurement of environmental attributes over an extended period of time to determine status or trends in the environmental attribute being monitored.

Research is the measurement of environmental attributes to test a specific hypothesis.

An *environmental attribute* may be any biotic or abiotic feature of the environment which can be measured.

Linkages between monitoring and research

When properly designed, monitoring data can be analyzed as part of a research program.

Similarly, the results of a properly designed research program will suggest changes to be made in monitoring activities.

Frequently, a change in a given indicator (above an appropriate threshold value) will trigger a research program to more explicitly describe the cause and effect relationship responsible for the noted change.

MONITORING AND RESEARCH

Standard Protocols

To be effective a monitoring program must ensure compatibility of measurements over time. This requires the development of standard protocols for the collection and analysis of data.

GCMRC will undertake a review of all current proposals in FY 1998. The objective will be to establish standard protocols for the collection and analysis of monitoring data through the 5-year plan.

Any changes in these protocols, in response to new knowledge or advances in technology, will only be undertaken after a review which ensures that data comparability between the new and old protocols.

Programmatic Integration

Similarly, the GCMRC monitoring must ensure that data collected in one program can be linked to the data needs of other programs.

For example, one must ensure that the sediment parameters monitored by the physical sciences program include those that are useful to the cultural and biological resources programs.

Flexibility and Surprise

Finally, the GCMRC long-term monitoring program will be designed with flexibility and contingency plans to address surprises which can arise from unanticipated events or new knowledge.

THE GEOGRAPHICAL AND INSTITUTIONAL SCOPE OF THE LONG-TERM MONITORING AND RESEARCH PROGRAM

Area to be monitored

The area to be monitored is primarily the Colorado River corridor between Glen Canyon Dam and Lake Mead reservoir.

The lateral extent of the monitoring effort is defined by the extent of processes and conditions influenced by dam discharges and river flows associated with operating criteria in the ROD.

Thirteen reaches, varying in length between 2 and 12 miles were established by GCES as Geographic Information System (GIS)-reaches.

These sites were selected because they represent reaches of the Colorado River in which there were ongoing studies or potentially important ecological conditions.

Additional sites may be selected as programs proceed, to adequately represent geomorphically, ecologically or culturally distinctive reaches of the Grand Canyon. The research reaches may be revised as a result of the synthesis activities.

II. GCMRC approach to developing the plan.

45 minutes

GCMRC APPROACH TO DEVELOPING A LONG-TERM MONITORING AND RESEARCH STRATEGIC PLAN.

Starts with management objectives --> provides the basis for developing the long-term monitoring and research plan.

Develop, a conceptual model of the system to provide a framework for the articulation and testing of our understanding of the system.

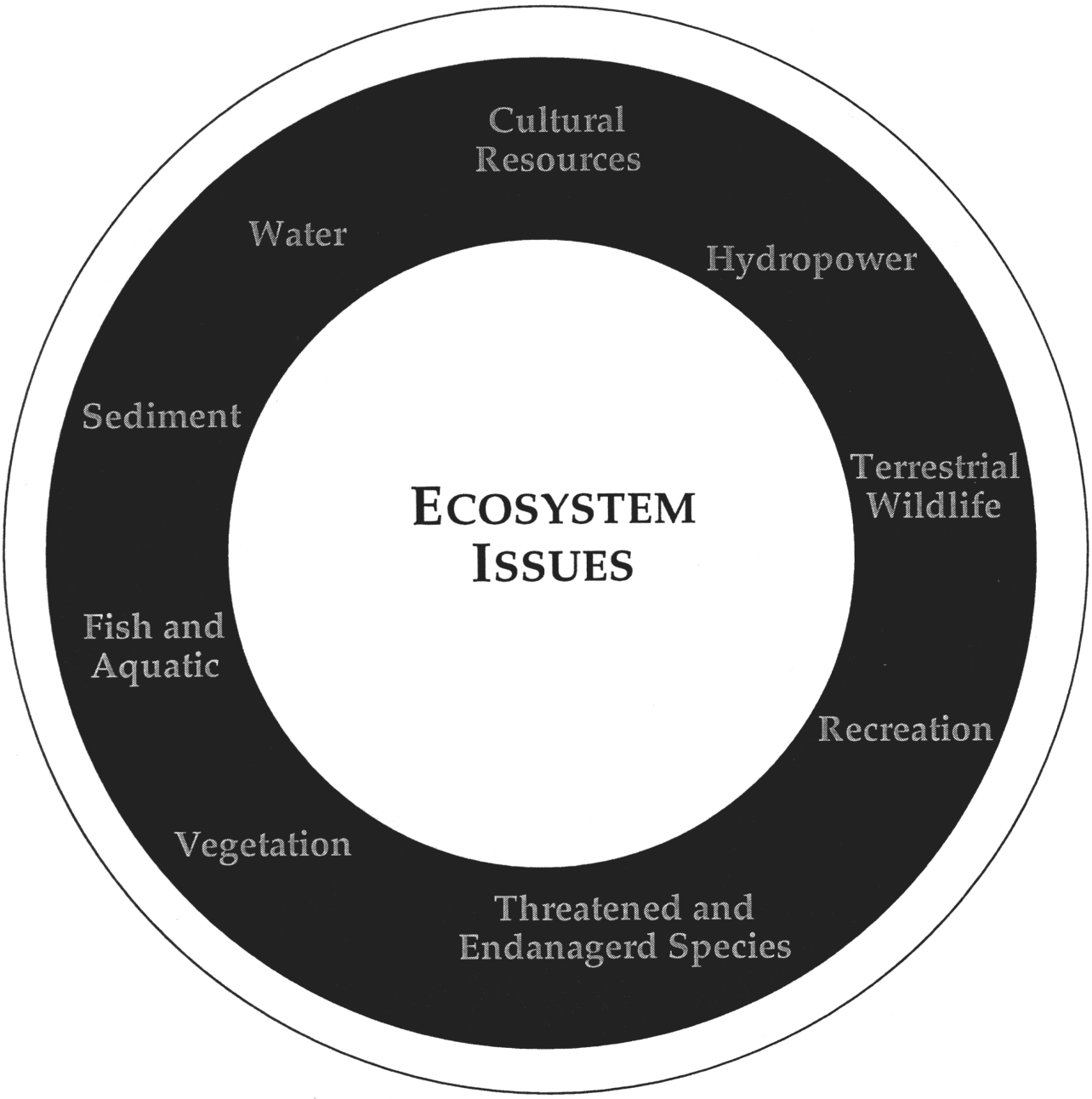
Undertake "state-of-the-science" assessments intended to synthesize and integrate existing knowledge of how the system functions.

Following the development and validation of the conceptual model, select initial attributes to be monitored based on the management objectives and the key drivers of change identified through the modeling activities.

Ensure that the parameters to be monitored are monitored in a scheme that accounts for the spatial and temporal characteristics of the Grand Canyon ecosystem. (i.e., use of representative areas).

Check to ensure that the program will provide information, over the long-run, on the response of the Grand Canyon ecosystem to alternative operations of Glen Canyon Dam.

To reiterate, long-term monitoring should be designed to provide regular feedback for adaptive management which permits mid-course adjustments in the operations of the Glen Canyon dam to ensure achievement of the goals of the Record of Decision (1996) and the management objectives articulated by the stakeholders.


Cultural Resources
Hydropower
Terrestrial Wildlife
Recreation
Threatened and Endanagerd Species
Vegetation
Fish and Aquatic
Sediment
Water
ECOSYSTEM ISSUES

IDENTIFICATION OF STAKE HOLDER INFORMATION NEEDS FOR THE GRAND CANYON MONITORING AND RESEARCH CENTER

- CULTURAL RESOURCES
- RIPARIAN AND TERRESTRIAL VEGETATION RESOURCES
- WATER RESOURCES
- SEDIMENT RESOURCES
- FISH AND AQUATIC RESOURCES
- NATIVE TERRESTRIAL WILDLIFE RESOURCES
- RECREATION RESOURCES

REVIEW OF PAST MONITORING ACTIVITIES

Deficiencies

Reviews of monitoring programs by the NRC (National Research Council, 1990, 1992, 1994a, 1994b, 1995), Lee (1993), Davis (1993) Davis et. al. (1994), EMTC (1995), and Noon (1996) have identified the following deficiencies in past environmental monitoring programs:

-- minimal foundation in current ecological theory / knowledge

-- lack of a conceptual model and little logic to support selection of parameters to be monitored

-- inadequate understanding of associations and causation

-- weak linkages between monitoring and research programs

-- weak definition of ranges of natural variability

-- inability to distinguish signal from noise in parameters being monitored (i.e., inability to separate natural variability from human induced variability)

-- trigger points not identified (i.e., When will a stressor drive an ecosystem outside the bounds of sustainable variation?)

-- inadequate and inconsistent levels of funding

-- no connection to decision-making; weak linkages to stakeholder objectives and information needs

REVIEW OF PAST MONITORING ACTIVITIES

Lessons Learned

-- Experience with the development of long-term monitoring and research programs in an adaptive management framework suggest that it takes at least two years to develop a sound long-term monitoring program.

-- Critical to the design of a sound long-term monitoring and research program is the development, during the start-up of the program, of a conceptual model of the system being studied, and "state-of-the-science" assessments of existing knowledge.

-- Monitoring programs must be designed with appropriate statistical power in order to detect the desired level of change in the parameters being monitored.

-- Research linkages to monitoring programs must be explicit and/or deterministic in nature.

--Monitoring programs must be designed to provide information that is useful to managers and other stakeholders.

-- Managers must ensure that adequate and continued financial support is provided.

DEVELOPING A CONCEPTUAL MODEL OF THE SYSTEM(S)

The GCMRC will assemble or contract with a group of modelers to:

-- convene a meeting to define the scope of the problem, design 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 at the first workshop;

-- convene an initial modeling workshop to develop the conceptual model (identifies critical relationships that structure the system), key information gaps, and initial priorities for monitoring and research. This workshop will take 5 - 10 days, and involve scientists and stakeholders knowledgeable about the Grand Canyon ecosystem.

-- convene a second modeling workshop designed to refine the conceptual model for use in simulating the system and begin testing the effects of alternative management strategies.

This "working" strategic model would continue to be refined and developed over the course of operations of the long-term monitoring and research program.

More detailed submodels for specific elements of the system (i.e., riparian vegetation, cultural resources, etc.) would be developed as needed.

WHY UTILIZE A MODELING APPROACH?

Define and focus what one monitors; limits research activities to critical questions.

Good simulation models are elegant representations of the ecosystem being studied. That is they are simplifications which contain only the level of complexity needed to describe the behavior being modeled.

Ecosystem models should not be confused with engineering models that produce results which accurate enough for use in decision-making.

The process of building a simulation model of an ecosystem provides an opportunity to test assumptions and to develop a shared view among scientists and managers of what is being managed and what the management objectives are.

Computer models are precise and consistent (even when they are wrong), require assumptions and relationships to be written out explicitly so they can be criticized and understood by anyone, can contain many variables and keep track of them simultaneously, can be changed and tested quickly, and provide a platform for thought experiments (Meadows, et. al. 1982)

SYNTHESIS OF KNOWLEDGE

- Pre and Post Dam Synthesis of Knowledge on Colorado River Resources

  - Defining critical attributes
  - Defining resource and attribute linkages and associations
  - Defining attribute normal range of variation, thresholds

SYNTHESIS OF KNOWLEDGE

- Assessment of Critical Resource/Attribute Changes in one to three non-dammed Western Riverine Systems

  - Defining critical attributes
  - Defining resource and attribute linkages and associations
  - Defining attribute normal range of variation, thresholds

SYNTHESIS OF KNOWLEDGE

- Define Potential Impacts of Glen Canyon Dam Operating Criteria on Water Quality Attributes in Lake Powell

  - One year Assessment
  - Water quality Attributes
    - Physical
    - Chemical
    - Biological
  - External review and oversight

PILOT MONITORING ACTIVITIES

During the first two years of activities, pilot monitoring studies based on the current GCES activities and the results of a series of workshops with scientists who have been working on the Grand Canyon ecosystem will be implemented.

Substantial revision to this pilot monitoring program is likely to result in response to the development of a conceptual model of the system and synthesis in various resource areas.

III. Individual Programs

60 minutes

PHYSICAL RESOURCES PROGRAM

Monitoring and research efforts will concentrate on four aspects of these physical resources as follows:

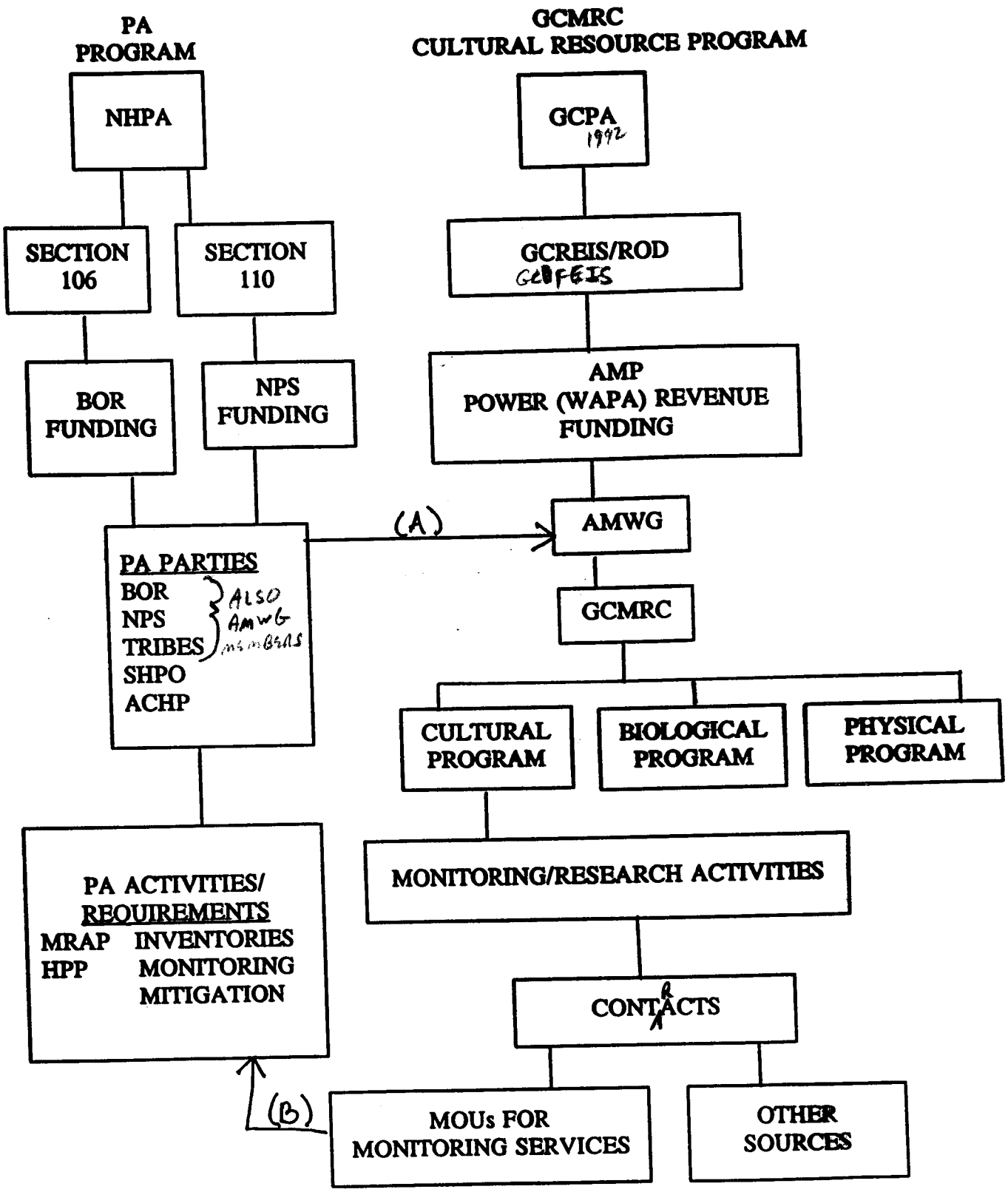
1. Dam discharges and instream flows.

2. Sediment balance and process.

3. Interrelationship of mainstem water and sediment and side channel inflows.

4. Interaction of mainstem water and sediment and Lake Mead resources.

CULTURAL RESOURCES


PA PROGRAM
NHPA
SECTION 106
SECTION 110
BOR FUNDING
NPS FUNDING
PA PARTIES
BOR
NPS
TRIBES
SHPO
ACHP
ALSO AMWG MEMBERS
(A)
PA ACTIVITIES/ REQUIREMENTS
MRAP INVENTORIES
HPP MONITORING
MITIGATION
(B)
GCMRC CULTURAL RESOURCE PROGRAM
GCPA 1992
GCREIS/ROD
GCDFEIS
AMP POWER (WAPA) REVENUE FUNDING
AMWG
GCMRC
CULTURAL PROGRAM
BIOLOGICAL PROGRAM
PHYSICAL PROGRAM
MONITORING/RESEARCH ACTIVITIES
CONTRACTS
MOUs FOR MONITORING SERVICES
OTHER SOURCES

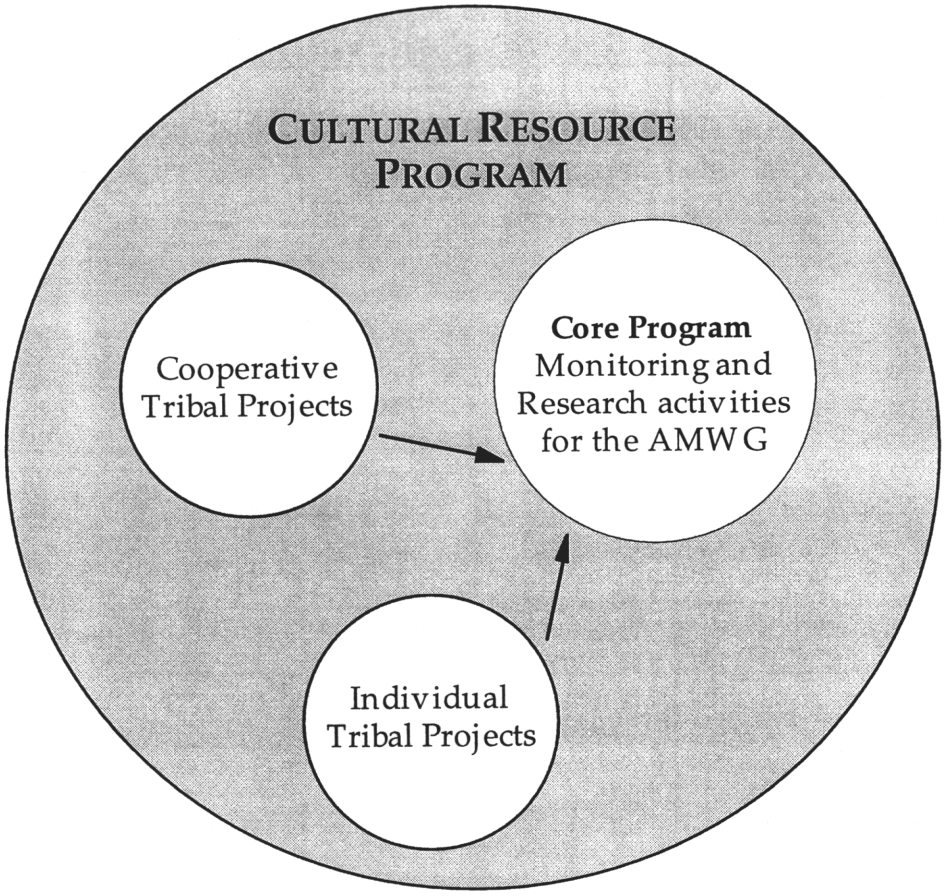


Figure 6.6. Primary Components of the Cultural Resources Program.

IDENTIFICATION OF STAKE HOLDER INFORMATION NEEDS

FOR THE

GRAND CANYON MONITORING AND RESEARCH CENTER

CULTURAL RESOURCES

- **Develop data and monitoring systems to assess:**
  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 assumed 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**

DEFINING STAKE HOLDER OBJECTIVES

FOR THE

GRAND CANYON MONITORING AND RESEARCH CENTER

CULTURAL RESOURCES

Cultural resources include prehistoric and historic archaeological sites, structures and properties of interest to all Americans.

- Primary Target: Conserve "in situ' all the downstream cultural resources to take into account Native American cultural resource concerns in Glen and Grand Canyon

- Secondary Target: If "in situ" conservation is not possible, design and implement mitigative strategies that integrate the full consideration of the values of all concerned tribes, with in applicable laws, using a scientific approach

- Primary Target: Maintain and integrate all cultural data recovered from monitoring, remedial, and mitigative action for those sites affected by dam operations and incorporate these data into the evolving research designs for understanding the human occupation and use of the Grand and Glen Canyons

PROPOSED MONITORING AND RESEARCH ACTIVITIES

1. Develop data and monitoring systems to assess impacts.

2. Develop data to assess risk of damage and loss from varying flow regimes.

3. Develop tribal monitoring programs for the evaluation of impacts to cultural resources.

4. Develop a predictive model of geomorphic processes that are related to archaeological site erosion.

5. Develop mitigation strategies related to documented dam impacts to sites by monitoring assessments.

6. Characterize resource values through scientific study.

THE BIOLOGICAL RESOURCES PROGRAM

Program Goals

-- Address stakeholder objectives and information needs.

-- Develop information about the structure (building blocks / habitat / communities) and function (processes) of the Grand Canyon ecosystem.

-- Prediction of ecosystem responses to alternative dam operations.

-- Implement ecosystem management strategies within an adaptive management framework.

Program Elements

(1) **inventory** the biological resource components of the Grand Canyon ecosystem and develop a conceptual model of the linkages between the biotic and abiotic components of the ecosystem,

(2) **monitoring** of ecosystem behavior, both short and long-term, to determine if the Grand Canyon ecosystem behaves as predicted, both in response to natural perturbations and alternative dam operations, and

(3) **research** to explore cause and effect relationships, test alternative hypotheses, and develop an improved understanding of the ecosystem.

Ecosystem degradation is not inevitable; it is simply cheaper and easier for some in the short term. Ecosystem health is also not inconsistent with economic imperatives and political realities. In fact, a healthy environment is the basis for a healthy economy. **(Likens, G.E. 1992)**

STAKEHOLDER OBJECTIVES

-- Fish and Aquatic Resources

-- Riparian and Terrestrial Vegetation Resources

-- Wildlife

-- Threatened and Endangered Species

PROPOSED MONITORING AND RESEARCH ACTIVITIES

Fish.

a. aquatic food base
b. reproduction, recruitment and growth of native fishes
c. reproduction, recruitment and growth of non-native warm water and cool water fishes including trout.
d. habitat condition and availability
e. competition and predator-prey interactions

Vegetation.

a. area and species composition of woody riparian plants
b. area and species composition of emergent marsh plants

Wildlife and wildlife habitat.

a. area and species composition of riparian habitat for associated vertebrates and invertebrates
b. aquatic food base for wintering waterfowl

Threatened and endangered species, their habitat and food base.

a. humpback chub
b. razorback sucker
c. bald eagle
d. peregrine falcon
e. southwestern willow flycatcher
f. belted kingfisher
g. Kanab ambersnail
h. other federal and state species of concern

[Based on stakeholder objectives and information needs, Patten et al. (1993), EIS, GCES Phase I & II studies, and resource sheets.]

AQUATIC FOOD BASE

Many wildlife species, including fish, depend on the aquatic food base for their survival.

Fluctuations in the aquatic food base resulting from dam operations or other factors may trigger changes in some or all of the populations of native and non-native fish species.

The long-term monitoring program should explore how the biomass, habitat, and composition of the aquatic food base will respond to alternative dam operations.

FISH

Fish are an important part of the Colorado River ecosystem because of their trophic role, important recreational value, and the T&E status of some species.

Changes in the structure and/or function of the Grand Canyon ecosystem resulting from alternative dam operations may result in decline or failure of fish populations. (i.e., Low temperature hypolimnetic releases from dams may have negative effects on population dynamics and recruitment of some warm-water riverine species. Successful fish recruitment may be influenced by: hydrology & transport; zooplankton production; & larval fish quantity. Backwater habitats may be important nursery areas for young native fishes, but are also used extensively by many non-native fishes. Finally, non-native fishes in Grand Canyon may pose a threat to the native species with competition for resources, predation, and parasites and diseases.)

Possible Monitoring Objectives

Hydrograph of the LCR to examine the relationship between flow timing, magnitude, sediment load and year class strength.

Relative abundance of adult humpback chub as an index of the long-term trend of the population.

Habitat quality, selection, and use by native and non-native fish.

How alternative dam operating scenarios effect non-native species and influences intrusion by these fish into the Grand Canyon ecosystem.

TROUT

Trout were first introduced into spring-fed tributaries of the Colorado River in Grand Canyon during the early 1900s. Seasonally warm water temperatures and high sediment loads probably precluded their sustained use of the mainstem prior to closure of Glen Canyon Dam.

Stocking of trout below Glen Canyon Dam began in 1964 and has continued to date.

Natural reproduction occurs but has been insufficient to sustain desired trout numbers.

The 25 km Lees Ferry reach below Glen Canyon Dam is managed for the production of trophy-sized trout.

Alternative dam operations and the resulting flow regime can directly (i.e., stranding of all life stages in isolated pools, dewatering of spawning and rearing habitats, and displacement of individuals from preferred habitats) and indirectly (i.e., ecosystem processes and lower trophic levels which provide the food base for the fish) affect trout found in the dam tailwater.

Possible Monitoring Objectives

Growth, survivorship, and changes in population structure, including the contribution from natural reproduction, over time.

RIPARIAN VEGETATION

The riparian vegetation communities along the Colorado River and its tributaries are important for stream bank stability, fish and wildlife habitat, and aesthetic and recreational values.

Those along the mainstem of the Colorado River are composed of the old high water zone (OHWZ) and the new high water zone (NHWZ) riparian communities, and the near shoreline wetland communities.

Possible Monitoring Objectives

Monitoring of NPS quadrats should be reviewed and continued as appropriate.

RIPARIAN FAUNA

Riparian faunal habitat relations have not been well established in the Grand Canyon.

Possible Monitoring Objectives

Monitoring of faunal assemblages should be aligned to sampling of riparian vegetation habitat changes.

INVERTEBRATES

Terrestrial invertebrates along the Colorado River in Grand Canyon provide essential food resources for riparian insectivores (insects, amphibians, reptiles, birds and mammals), thereby linking vegetation, productivity and habitat conditions with secondary consumer population dynamics.

Possible Monitoring Objectives

Monitoring of selected key taxa would permit evaluation of changes that may be a response to dam operations.

VERTEBRATES

Terrestrial riparian vertebrate populations in the Grand Canyon ecosystem are trophically significant secondary consumers, integrating habitat conditions. The Grand Canyon ecosystem supports high densities of terrestrial/riparian vertebrates and populations of many species are changing.

Herpetofauna

Herpetofaunal species in this system are rare.

They require baseline inventory level study.

Avifauna

Avifauna are especially conspicuous and are trophically significant secondary consumers, integrating habitat structure, food resource production and predator populations.

Several avian species are federally listed T&E species, or are considered for listing, including bald eagle, peregrine falcon, and S.W. willow flycatcher.

Avifauna monitoring should emphasize listed species, wintering and breeding waterfowl, riparian obligate species, resident non-obligate species, and migrant species.

Mammals

Most mammal species in this system are nocturnal and require baseline population study. Mammal species can be used to monitor trophic dynamics, response to human use levels and interactions with other herbivores.

Scat and spot observations can be used to document distributional data for larger mammals.

SOCIOECONOMIC RESOURCES PROGRAM

Develop a cost benefit analysis model for evaluating alternative dam operating criteria on ecosystem resources.

DEFINING STAKE HOLDER OBJECTIVES

FOR THE

GRAND CANYON MONITORING AND RESEARCH CENTER

RECREATION

Provide quality recreational opportunities that do not adversely impact natural or cultural resources within the river corridor.

- **Maintain or improve the wilderness character of the recreational experience**
- **Maintain flows and sediment processes that create and adequate quantity, distribution and variety of beaches for camping, as long as such flows are consistent with management of other resource values**
- **Maintain flow that do not preclude navigability by white water craft in the Grand Canyon and power craft in Glen Canyon and upper Lake Mead**
- **Maintain quality cold water fishery opportunities in Glen Canyon**
- **Maintain sport hunting opportunities for waterfowl in Glen Canyon**

IDENTIFICATION OF STAKE HOLDER INFORMATION NEEDS

FOR THE

GRAND CANYON MONITORING AND RESEARCH CENTER

RECREATION RESOURCES

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

PROPOSED MONITORING AND RESEARCH ACTIVITIES

1. Determine if recreation is enhanced and safety improved over impacts resulting from historical dam operations.

2. Determine if changes in recreational patterns resulting from selected dam operations have an effect on the Canyon's downstream resources.

3. Incorporating existing information, compile data on use and changes resulting from recreation on two year intervals.

4. Monitor beach area data using aerial, video, or photography every other year.

5. Monitor recreationists values and concerns on a five year basis or following unusual events.

INFORMATION TECHNOLOGIES RESOURCES PROGRAM

Several areas of focus will be implemented in the information technology programming, including the following:

1. Development of protocols for data collection, processing and use.

2. Development of extensive databases across all resources and a database management system.

3. Development of a robust geographic information system to accommodate multiple layers associated with all resources of interest to stakeholders.

4. Development of databases associated with remotely sensed data, here to date not incorporated in the GCES database system.

5. Stakeholder direct access to selected data and information in the database management system and GIS.

6. Development of outreach programs to transport data and information to stakeholders.