THE U.S. BUREAU OF RECLAMATION
UPPER COLORADO REGIONAL OFFICE
GLEN CANYON DAM
ADAPTIVE MANAGEMENT PROGRAM

FISCAL YEAR 2006 BUDGET & WORK PLAN

by

The U.S. Bureau of Reclamation
Upper Colorado Regional Office
Salt Lake City, Utah

Draft February 15, 2005

PROJECT TITLE AND ID: A.1. Personnel Costs

General Project Description: This project represents Reclamation staff costs to perform the daily work activities required to operate the Adaptive Management Work Group. The work includes completing assignments resulting from AMWG meetings, consulting with stakeholders on a variety of AMP issues relating to the operation of Glen Canyon Dam (GCD), disseminating pertinent information to the AMWG, preparing and tracking budget expenses, and updating Reclamation's web page.

Project Goals and Objectives: The **primary goal** is to perform all work associated with the AMWG in a timely and efficient manner, while using the funds available as prudently as possible. **Secondary goals** include increasing each stakeholder's awareness of significant budget and legislative issues related to the AMP, improving working relationships with the AMWG members/alternates, finding constructive ways to resolve differences, and addressing individual concerns in an open and accepting forum of discussion.

Expected Results: Personnel costs will not exceed what has been proposed in the budget and Reclamation staff will provide budget information to the AMWG on a regular basis. Completed work products will be of high quality and promptly distributed to AMWG members/alternates and interested parties. Budget reports will be presented in a format conducive to AMWG needs.

Budget: $159,418

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside USBR Science/Labor	--	--	--	--	--
Logistics Field **Support**	--	--	--	--	--
Project Related **Travel/Training**	--	--	--	--	--
Operations/Supplies	--	--	--	--	--
USBR Salaries	**118,990**	**126,290**	**110,230**	**113,537**	**116,375**
Subtotal	**118,990**	**126,290**	**110,230**	**113,537**	**116,375**
DOI Customer Burden (27%)	**44,010**	**46,710**	**40,770**	**41,993**	**43,043**
Project Total	**163,000**	**173,000**	**151,000**	**155,530**	**159,418**
% Total Outsourced	--	--	--	--	--

PROJECT TITLE AND ID: **A.2. AMWG Member Travel Reimbursement**

General Project Description: This project covers the costs to reimburse AMWG members or alternates to attend regularly scheduled AMWG meetings.

Project Goals and Objectives: The primary goal for reimbursing travel expenses to AMWG members or alternates is to encourage their attendance at all meetings. Because the meetings are often scheduled in Phoenix, Arizona, many members must incur air or POV travel, and by having Reclamation reimburse those and other related travel costs, e.g., hotel, per diem, rental car, etc., opportunities are increased for more members to participate in a variety of AMWG assignments. Also, because Reclamation can purchase airline tickets at the Federal Government rate, there are additional cost savings to the program.

Expected Results: The Glen Canyon Dam Adaptive Management Program will benefit from having all the AMWG members participate in regularly scheduled meetings. As a collective body, they address and resolve concerns associated with the operation of Glen Canyon Dam and make recommendations to the Secretary of the Interior for continued science efforts performed below the GCD.

Budget: $13,390

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside USBR Science/Labor	--	--	--	--	--
Logistics Field **Support**	--	--	--	--	--
Project Related **Travel/Training**	10,000	10,000	10,000	13,000	13,390
Operations/Supplies	--	--	--	--	--
USBR Salaries	--	--	--	--	--
Subtotal	10,00	10,000	10,000	13,000	13,390
DOI Customer Burden (27%)	--	--	--	--	--
Project Total	10,000	10,000	10,000	13,000	13,390
% Total Outsourced	--	--	--	--	--

PROJECT TITLE AND ID: **A.3. Reclamation Travel**

General Project Description: This project covers travel expenses Reclamation staff incur to attend AMWG and ad hoc group meetings. In order to work on AMWG/ad hoc assignments, the meetings are often held in Phoenix, Arizona. As such, Reclamation staff must make additional trips throughout the year in completion of those assignments.

Project Goals and Objectives: The primary goal is for Reclamation staff to be able to travel to meetings and participate in completing AMWG/TWG assignments. By doing so, the program benefits from greater interaction among its members as well as continued improvement and commitment to operating GCD in the best manner possible and obtaining the results from science work being done in the canyon.

Expected Results: Reclamation staff will be involved with AMWG/TWG members in completing work assignments and resolving issues that affect the AMP. They will develop better working relationships with all involved and work toward consensus on a variety of sensitive issues.

Budget: $ 13,000

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside USBR Science/Labor	--	--	--	--	--
Logistics Field **Support**	--	--	--	--	--
Project Related **Travel/Training**	**18,000**	**18,000**	**18,000**	**15,540**	**13,000**
Operations/Supplies	--	--	--	--	--
USBR Salaries	--	--	--	--	--
Subtotal	**18,000**	**18,000**	**18,000**	**15,540**	**13,000**
DOI Customer Burden (27%)	--	--	--	--	--
Project Total	**18,000**	**18,000**	**18,000**	**15,540**	**13,000**
% Total Outsourced	--	--	--	--	--

PROJECT TITLE AND ID: **A.4. Facilitation Contract**

General Project Description: This project represents the work assigned to one individual under contract to the Bureau of Reclamation to facilitate at Adaptive Management Work Group meetings. This person may also assist AMWG ad hoc groups in completing AMWG assignments.

Project Goals and Objectives: The facilitator's primary responsibility is to keep the AMWG meetings organized and help the members reach consensus on important issues. The facilitator creates a setting in which all members and the public are able to express their views.

Results: The facilitator will create an atmosphere in which the members and other participants at AMWG meetings feel comfortable expressing their individual viewpoints. The facilitator will bring the AMWG members to consensus on pertinent issues affecting the GCD AMP.

Budget: $25,000

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
USBR Reimbursements	25,000	25,000	21,000	21,000	25,000
Logistics Field Support	--	--	--	--	--
Project Related Travel/Training	--	--	--	--	--
Operations/Supplies	--	--	--	--	--
USBR Salaries	--	--	--	--	--
Subtotal	25,000	25,000	21,000	21,000	25,000
DOI Customer Burden (27%)	--	--	--	--	--
Project Total	25,000	25,000	21,000	21,000	25,000
% Total Outsourced	--	--	--	--	--

PROJECT TITLE AND ID: **A.5. Other**

General Project Description: This project represents some of the other "miscellaneous" expenses incurred in operation of the AMWG. For example:

- overnight mailings of AMWG meeting packets
- copying of reports
- purchasing meeting materials (cassette tapes, markers, paper, software upgrades for AMP website posting, etc.)
- equipment (audio recording/transcribing machines)

In addition to the above, training courses are often required for staff to keep current on environmental issues, Federal Advisory Committee Act changes, computer technology improvements, etc.

Also included in this category are monetary awards given to Reclamation staff who have contributed significantly to the success of the GCDAMP.

Project Goals and Objectives: The primary goal is to limit spending on "other" items as much as possible. By doing so, more money can be applied to science and research.

Expected Results: Other expenses will be kept to a minimum in an effort to reduce the administrative portion of the AMP budget.

Budget: $7,175

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside USBR Science/Labor	--	--	--	--	--
Logistics Field **Support**	--	--	--	--	--
Project Related **Travel/Training/Awards**	6,000	6,000	6,000	5,000	5,000
Operations/Supplies	2,000	2,000	3,000	2,000	2,175
USBR Salaries	--	--	--	--	--
Subtotal	8,000	8,000	9,000	7,000	7,175
DOI Customer Burden (27%)	--	--	--	--	--
Project Total	8,000	8,000	9,000	7,000	7,175
% Total Outsourced	--	--	--	--	--

PROJECT TITLE AND ID: **B.1. Personnel Costs**
This project represents Reclamation staff costs to perform the daily work activities required to operate the Technical Work Group, a subgroup of the AMWG. The work includes completing assignments resulting from TWG meetings, consulting with stakeholders on a variety of AMP issues relating to the operation of Glen Canyon Dam, disseminating pertinent information to the TWG, preparing and tracking budget expenses, and updating Reclamation's web page.

Project Goals and Objectives: This project represents Reclamation staff costs to perform the daily work activities required to operate the Technical Work Group. The work includes completing assignments resulting from AMWG or TWG meetings, consulting with stakeholders on a variety of AMP issues relating to the operation of Glen Canyon Dam, disseminating pertinent information to the TWG, preparing and tracking budget expenses, and updating Reclamation's web page.

Expected Results: Personnel costs will not exceed what has been proposed in the budget and Reclamation staff will provide budget information to the TWG on a regular basis. Completed work products will be promptly distributed to TWG members/alternates and interested parties.

Budget: $72,847

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside USBR Science/Labor	--	--	--	--	--
Logistics Field **Support**	--	--	--	--	--
Project Related **Travel/Training**	--	--	--	--	--
Operations/Supplies	--	--	--	--	--
USBR Salaries	**54,020**	**56,940**	**50,370**	**51,881**	**53,178**
Subtotal	**54,020**	**56,940**	**50,370**	**51,881**	**53,178**
DOI Customer Burden (27%)	**19,980**	**21,060**	**18,630**	**19,189**	**19,669**
Project Total	**74,000**	**78,000**	**69,000**	**71,070**	**72,847**
% Total Outsourced	--	--	--	--	--

PROJECT TITLE AND ID: **B.2. TWG Member Travel Reimbursement**

General Project Description: This project covers the costs to reimburse TWG members or alternates to attend regularly scheduled TWG meetings.

Project Goals and Objectives: The primary goal for reimbursing travel expenses to TWG members or alternates is to encourage their attendance at all meetings. Because the meetings are often scheduled in Phoenix, Arizona, many members must incur air or personal vehicle travel. By reimbursing those and other related travel costs, e.g., hotel, per diem, rental car, etc., opportunities are increased for more members to participate in a variety of AMWG/TWG assignments.

Expected Results: The Glen Canyon Dam Adaptive Management Program will benefit from having all the TWG members participate in regularly scheduled meetings. As a collective body, they address and resolve concerns associated with the operation of Glen Canyon Dam and make recommendations to the AMWG for continued research in the canyon.

Budget: $20,836

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside USBR Science/Labor	--	--	--	--	--
Logistics Field **Support**	--	--	--	--	--
Project Related **Travel/Training**	10,000	10,000	15,000	15,540	20,836
Operations/Supplies	--	--	--	--	--
USBR Salaries	--	--	--	--	--
Subtotal	10,000	10,000	15,000	15,540	20,836
DOI Customer Burden (27%)	--	--	--	--	--
Project Total	10,000	10,000	15,000	15,540	20,836
% Total Outsourced	--	--	--	--	--

PROJECT TITLE AND ID: **B.3. Reclamation Travel**

General Project Description: This project covers travel expenses Reclamation staff will incur to prepare and attend TWG meetings as well as ad hoc group meetings which result from AMWG/TWG assignments. In order to work on those assignments, the meetings are often held in Phoenix, Arizona, because it is centrally located to those entities/states represented on the AMWG/TWG. This often requires Reclamation staff to make additional trips throughout the year in completion of AMWG/TWG assignments.

Project Goals and Objectives: The primary goal is for Reclamation staff to be able to travel to meetings and participate in completing AMWG/TWG assignments. By doing so, the program benefits from greater interaction among its members as well as continued improvement and commitment to operating GCD in the best manner possible and for obtaining the necessary results from science work done in the canyon.

Expected Results: Reclamation staff will continue to be involved in meeting with AMWG/TWG members in completing work assignments and resolving issues that affect the operation of GCD. They will develop better working relationships with all involved and work toward consensus on a variety of AMP issues.

Budget: $ 15,898

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside USBR Science/Labor	--	--	--	--	--
Logistics Field **Support**	--	--	--	--	--
Project Related **Travel/Training**	**18,000**	**18,000**	**17,000**	**15,510**	**15,898**
Operations/Supplies	--	--	--	--	--
USBR Salaries	--	--	--	--	--
Subtotal	**18,000**	**18,000**	**17,000**	**15,510**	**15,898**
DOI Customer Burden (27%)	--	--	--	--	--
Project Total	**18,000**	**18,000**	**17,000**	**15,510**	**15,898**
% Total Outsourced	--	--	--	--	--

PROJECT TITLE AND ID: **B.4. TWG Chair Reimbursement**

General Project Description: This project represents the work assigned to one individual under contract to the Bureau of Reclamation to act as chairperson at Technical Work Group meetings. This person may also work on AMWG/TWG ad hoc group assignments.

Project Goals and Objectives: The chairperson's primary responsibility is to conduct regularly scheduled TWG meetings. The chairperson also participates in ad hoc group assignments and works closely with Reclamation and GCMRC in setting meeting agendas. The chairperson follows up on TWG and ad hoc group assignments and ensures that information is shared with the members and alternates in a timely manner.

Expected Results: The chairperson creates an atmosphere in which the members and other participants at TWG meetings feel comfortable expressing their individual viewpoints. The chairperson will bring the TWG members to consensus on sensitive issues with the ultimate goal of making recommendations to AMWG that incorporate the best scientific information available to the GCDAMP. The chairperson will follow up on action items and make assignments as necessary to accomplish TWG objectives.

Budget: $22,171

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside USBR Science/Labor	25,000	25,000	21,000	21,630	22,171
Logistics Field Support	--	--	--	--	--
Project Related Travel/Training	--	--	--	--	--
Operations/Supplies	--	--	--	--	--
USBR Salaries	--	--	--	--	--
Subtotal	25,000	25,000	21,000	21,630	22,171
DOI Customer Burden (27%)	--	--	--	--	--
Project Total	25,000	25,000	21,000	21,630	22,171
% Total Outsourced	--	--	--	--	--

PROJECT TITLE AND ID: **B.5. Other**

General Project Description: This project represents some of the other "miscellaneous" expenses incurred in operation of the TWG. For example:

- overnight mailings of TWG meeting packets
- copying of reports
- purchasing meeting materials (cassette tapes, markers, paper, etc.)
- equipment (audio recording/transcribing machines)

Project Goals and Objectives: The primary goal is to limit spending on "other" items as much as possible. By doing so, more money can be spent on science and research.

Expected Results: Other expenses will be kept to a minimum in an effort to keep within the AMP budget.

Budget: $2,050

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside USBR Science/Labor	--	--	--	--	--
Logistics Field **Support**	--	--	--	--	--
Project Related **Travel/Training**	--	--	--	--	--
Operations/Supplies	2,000	2,000	2,000	2,000	2,050
USBR Salaries	--	--	--	--	--
Subtotal	2,000	2,000	2,000	2,000	2,050
DOI Customer Burden (27%)	--	--	--	--	--
Project Total	2,000	2,000	2,000	2,000	2,050
% Total Outsourced	--	--	--	--	--

PROJECT TITLE AND ID: **C. Compliance Documents**

General Project Description: This project covers the costs for preparing compliance documents for AMP-proposed actions in order to comply with the Endangered Species Act, National Environmental Policy Act, and National Historic Preservation Act.

Project Goals and Objectives: Reclamation staff will keep informed on any changes to the ESA, NEPA, and NHPA and will consult with AMWG stakeholders to ensure proper compliance is undertaken for actions taken in support of the GCDAMP.

Expected Results: Reclamation staff will be involved in all compliance issues related to the Glen Canyon Dam Adaptive Management Program. They will utilize travel expenses to meet with the AMP stakeholders to resolve any differences.

Budget: $22,450

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside USBR Science/Labor	--	--	--	--	--
Logistics Field **Support**	--	--	--	--	--
Project Related **Travel/Training**	--	--	--	--	--
Operations/Supplies	--	--	--	--	--
USBR Salaries	**26,000**	**26,000**	**26,000**	**26,780**	**22,450**
Subtotal	**26,000**	**26,000**	**26,000**	**26,780**	**22,450**
DOI Customer Burden (27%)	--	--	--	--	--
Project Total	**26,000**	**26,000**	**26,000**	**26,780**	**22,450**
% Total Outsourced	--	--	--	--	--

PROJECT TITLE AND ID: **D. Contract Administration**

General Project Description: This project covers the expenses for Reclamation staff to prepare and monitor contracts associated with the GCD AMP. Specifically, these contracts are for AMWG Facilitation, TWG Chairperson reimbursement, tribal participation, and Programmatic Agreement work.

Project Goals and Objectives: Reclamation contract specialists will accurately apply funds spent on individual contracts to ensure costs do not exceed contract limits. They will keep other Reclamation staff informed as to those charges so accurate reporting can be made to both AMWG and TWG members.

Expected Results: Contract specialists will ensure that individual contractors are fulfilling the requirements of their contracts. They will maintain accurate records of payments made against the contracts and will keep Reclamation staff informed of discrepancies or concerns. Work will be completed on time and within the limits of the contract.

Budget: $24,394

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside USBR Science/Labor	--	--	--	--	--
Logistics Field **Support**	--	--	--	--	--
Project Related **Travel/Training**	--	--	--	--	--
Operations/Supplies	--	--	--	--	--
USBR Salaries	**25,000**	**25,000**	**25,000**	**25,750**	**24,394**
Subtotal	**25,000**	**25,000**	**25,000**	**25,750**	**24,394**
DOI Customer Burden (27%)	--	--	--	--	--
Project Total	**25,000**	**25,000**	**25,000**	**25,750**	**24,394**
% Total Outsourced	--	--	--	--	--

PROJECT TITLE AND ID: **Public Outreach**

General Project Description: This project covers the expenses for Reclamation staff and the Public Outreach Ad Hoc Group (POAHG) to develop materials for the GCDAMP public outreach efforts.

Project Goals and Objectives: Reclamation Public Affairs Staff and POAHG will work jointly in developing materials to inform and educate the public on the goals and administration of the GCDAMP. They will keep other AMP members advised of progress and expenditures.

Expected Results: Products will include Fact Sheets, brochures, media articles, and other pertinent means of advising the public and program members on the achievements of the GCDAMP. The POAHG will maintain accurate records of payments made against the contracts and will keep Reclamation staff informed of discrepancies or concerns.

Budget: $50,000

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside USBR Science/Labor	--	--	--	--	--
Logistics Field **Support**	--	--	--	--	--
Project Related **Travel/Training**	--	--	--	--	--
Operations/Supplies	--	--	--	--	--
USBR Salaries	--	--	**0**	**0**	**50,000**
Subtotal	--	--	**0**	**0**	**50,000**
DOI Customer Burden (27%)	--	--	--	--	--
Project Total	--	--	**0**	**0**	**50,000**
% Total Outsourced	--	--	--	--	--

I

PROJECT TITLE AND ID: IIA. TRIBAL CONSULTATION: Cooperative Agreements with Tribes

Rationale/Problem Statement: Government-to-government consultation will be maintained between the five AMP tribes (Hopi Tribe, Hualapai Tribe, Southern Paiute Consortium, Pueblo of Zuni, Navajo Nation) and five Interior agencies (US Geological Survey, National Park Service, Reclamation, US Fish and Wildlife Service, and Bureau of Indian Affairs).

Integration: The purpose of the continued funding of tribal cooperative agreements is to ensure tribal viewpoints are integrated into continuing AMP dialogs, votes, and in the final recommendations made to the Secretary of the Interior.

Expected Products: The most important product is the incorporation of tribal perspectives into the recommendations forwarded to the Secretary. In addition, the tribes prepare annual reports on activities funded under the cooperative agreements. Continued funding of government-to-government consultation through the agreements ensure enhanced communication and understanding of the AMP issues and concerns.

Recommended Approach: A tribal consultation plan will be completed that may modify the current approach and will be an appendix to the AMP Strategic Plan.

Status: Ongoing.

External Project Awards: Tribal cooperative agreements are funded through appropriated dollars provided by five Department of the Interior agencies (USBR, NPS, FWS, BIA, and USGS). The cooperative agreements are administratively managed by Reclamation with funding provided by power revenues.

Project Accomplishments: Communication and government-to-government consultation between agencies, tribes, and other AMP stakeholders.

Schedule: Agreements are modified on a fiscal year basis. Each funded tribe must submit a yearly status report to Reclamation at the close of the fiscal year. Copies of the reports may be distributed to AMP stakeholders upon request.

Budget: The cost is $475,000 annually to fund the cooperative agreements with each agency contributing $95,000:

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside USBR Science/Labor	**400,000**	**400,000**	**320,000***	**400,000**	**410,000**
Logistics Field **Support**	--	--	--	--	--
Project Related **Travel/Training**	--	--	--	--	--
Operations/Supplies	--	--	--	--	--
USBR Salaries	--	--	--	--	--
Subtotal	**400,000**	**400,000**	**320,000**	**400,000**	**410,000**
DOI Customer Burden (27%)	--	--	--	--	--
Project Total	**400,000**	**400,000**	**320,000**	**400,000**	**410,000**
% Total Outsourced	--	--	--	--	--

* Total commitment is $400,000; however, $80,000 was administered directly by GCMRC.

PROJECT TITLE AND ID: IIB. TRIBAL CONSULTATION: River Trip Logistical Costs to GCMRC

Rationale/Problem Statement: River trips, at a logistical cost of $15,000 per tribe, were funded using power revenues to enable the tribes to identify resources of tribal concern, including traditional cultural properties eligible to the National Register of Historic Places. This identification effort was largely completed by the mid-1990s. Since then, the trips have been used by tribes to identify how and where dam operations are impacting identified resources or properties. Beginning in FY03, river trips were funded through appropriated dollars provided by the five DOI agencies.

Integration: River trips enable the tribes to identify impacts of dam operations on resources of tribal concern. Based on river trip observations, tribes identify concerns to other AMP stakeholders and ultimately to the Secretary of the Interior.

Expected Products: As the permitting agency, NPS requires an annual investigator report from each tribe conducting a river trip. In addition, the tribes are required to report to Reclamation or the AMP as a whole on whether conditions within the river corridor were stable, improving, or worsening. As a nominal variable, this can then be tracked over time to measure trends.

Recommended Approach: River trip costs have been limited to $15,000 per tribe per year. Beginning in FY06 these costs will be indexed by the CPI. The tribes are allowed to select the approach they take to the trips within this cost constraint and meeting NPS minimum tool requirements.

Status: Ongoing.

External Project Awards: None.

Project Accomplishments: Tribes have been able to identify resources or properties and to determine where and how dam operations affect those resources. This information will be used to develop treatment or mitigation plans for the array of resources of concern.

Schedule: A report is submitted to the NPS as a result of any trips undertaken during the year.

Budget: $76,875

FUNDING HISTORY	Fiscal year				
	2002	2003	2004 *	2005	2006
Outside USBR Science/Labor	75,000	75,000	60,000	75,000	76,875
Logistics Field **Support**	--	--	--	--	--
Project Related **Travel/Training**	--	--	--	--	--
Operations/Supplies	--	--	--	--	--
USBR Salaries	--	--	--	--	--
Subtotal	75,000	75,000	60,000	75,000	76,875
DOI Customer Burden (27%)	--	--	--	--	--
Project Total	75,000	75,000	60,000	75,000	76,875
% Total Outsourced	--	--	--	--	--

* An additional $15,000 was administered directly by GCMRC.

PROJECT TITLE AND ID: III.2. PROGRAMMATIC AGREEMENT:
Reclamation Administrative Costs for Programmatic Agreement

Rationale/Problem Statement: Reclamation's regional archeologist administers the PA program, tribal consultation cooperative agreements and river trip fund transfers to GCMRC. This project funds salary, travel, and indirect costs of program administration.

Integration: The costs help integrate the PA and tribal consultation into the larger AMP.

Expected Products: The major product is accountability for the cooperative agreements, contracts, and use of both appropriated dollars and power revenues.

Recommended Approach: Compliance with the Federal Acquisition Regulation and other accountability laws, regulations, and policies.

Status: Ongoing.

External Project Awards: Cooperative agreements with tribes and contract administration for competed projects.

Project Accomplishments: Moving towards completion of the stipulations in the programmatic agreement.

Schedule: The schedule is a continuation of previous work within the fiscal year.

Budget: $52,788

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside USBR Science/Labor	--	--	--	--	--
Logistics Field **Support**	--	--	--	--	--
Project Related **Travel/Training**	--	--	--	--	--
Operations/Supplies	--	--	--	--	--
USBR Salaries	50,000	50,000	43,000	51,500	52,788
Subtotal	50,000	50,000	43,000	51,500	52,788
DOI Customer Burden (27%)	--	--	--	--	--
Project Total	50,000	50,000	43,000	51,500	52,788
% Total Outsourced	--	--	--	--	--

PROJECT TITLE AND ID: III.2. PROGRAMMATIC AGREEMENT: Grand Canyon and Glen Canyon Treatment Plans

Rationale/Problem Statement: In consultation with Grand Canyon NPS, develop an RFP for the FY06 implementation of a treatment plan for the cultural resources of Grand Canyon based upon a treatment plan design completed in FY05. Treatment of individual properties may include in situ preservation measures, nature and extent testing, full data recovery or additional documentation/recordation.

It is anticipated that the bulk of development and implementation of the Glen Canyon treatment plan will be completed in FY05. Additional funds may be required in FY06 to finish the reporting task.

Administration of Glen Canyon and Grand Canyon cultural resource monitoring will be transferred to GCMRC in FY06. Funding for FY06 identified in the following table is for implementation of the treatment plans.

Integration: Not applicable.

Expected Products: Re-evaluations of all affected Glen and Grand Canyon properties for eligibility to the Nation Register of Historic Places. Mitigation of effects as determined by the treatment plans. Detailed and comprehensive reports on consultant activities, results and recommendations.

Recommended Approach: Evaluation, nature and extent testing, application of mitigative measures or total data recovery, following the Secretary of the Interior Standards and Guidelines for Historic Preservation and guidance of the Advisory Council on Historic Preservation.

Status: Ongoing.

External Project Awards: Competitive Requests for Proposals.

Project Accomplishments: The development of the Glen Canyon treatment plan will begin in March, 2005, followed by treatment plan implementation. An RFP for the Grand Canyon treatment plan will be advertised in FY2005 with work to begin in that year. An RFP for implementation of that plan will be advertised in FY06.

Schedule: The schedule is based on the fiscal year.

Budget: Treatment plan implementation is estimated at $250,000 for Grand Canyon. $20 will be reserved to complete the Glen Canyon implementation.

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside USBR Science/Labor	229,000	229,000	371,000	676,340	322,788
Logistics Field **Support**	--	--	--	--	--
Project Related **Travel/Training**	--	--	--	--	--
Operations/Supplies	--	--	--	--	--
USBR Salaries	--	--	--	--	--
Subtotal	229,000	229,000	371,000	676,340	322,788
DOI Customer Burden (27%)	--	--	--	--	--
Project Total	229,000	229,000	371,000	676,340	322,788
% Total Outsourced	--	--	--	--	--

THE U.S. GEOLOGICAL SURVEY
SOUTHWEST BIOLOGICAL SCIENCE CENTER
GRAND CANYON MONITORING AND RESEARCH CENTER

FISCAL YEAR 2006

MONITORING AND RESEARCH WORK PLAN

by

THE U.S. GEOLOGICAL SURVEY
SOUTHWEST BIOLOGICAL SCIENCE CENTER
GRAND CANYON MONITORING AND RESEARCH CENTER

Draft February 15, 2005

TABLE OF CONTENTS

CHAPTER 1

THE USGS, SBSC, GCMRC FY 2006 FINAL ANNUAL WORK PLAN

INTRODUCTION

The Fiscal Year 2006 (FY 2006) U.S. Geological Survey, Southwest Biological Science Center, Grand Canyon Monitoring and Research Center (GCMRC) Work Plan describes scientific activities intended to provide the information needed to address the management objectives developed by the Glen Canyon Dam Adaptive Management Work Group (AMWG). These management objectives have been recommended by the AMWG to the Secretary of the Interior to meet the intent of the 1992 Grand Canyon Protection Act (GCPA), and the Record of Decision (ROD, 1996) for the final Environmental Impact Statement on the operations of Glen Canyon Dam (GCDEIS, 1995).

THE GCMRC'S STRATEGY FOR DEVELOPING THE FY 2006 ANNUAL WORK PLAN

In response to constraints on science funding for the Adaptive Management program combined with an expanding assortment of research and monitoring needs identified by stakeholders, the GCMRC critically re-evaluate program planning during FY 2005. Because of increasing needs for science information without additional funding, the GCMRC identified several recommended adjustments in the science program to balance the following critical areas as it developed in the FY 2006 work plan and budget.

Core Monitoring to Document the Influence 1996 Record-of-Decision – This element stems from the list of key downstream resources identified within the *Operations of Glen Canyon Dam – Final Environmental Impact Statement*. These data provide the essential time series for use by both managers and scientists in evaluating environmental changes below the dam, despite the fact that such data alone cannot identify cause and effect. These data are deemed to be of great value to the Adaptive Management Program in and of themselves and provide a foundation on which experimental design can be built that does identify cause and effect. The "Downstream" report of the National Research Council (NRC, 1999)states "The Center has correctly identified the need for a scientifically sound, comprehensive, long-term monitoring program as a major priority." One example of this type of work is the continuous

monitoring of streamflow, temperature and suspended-sediment transport within the main channel of the Colorado River ecosystem and its major tributaries described within project A.2.

Research & Development to Improve Monitoring – This has been a fundamental component of the GCMRC activities since the Center was established in 1995. These activities are intended to identify effective and efficient methods for collection of monitoring data, as well as identify methods and needs for inventory of critical resources below the dam. The Center's Protocol Evaluation Program (PEP) for externally reviewing monitoring methods was started in 1998 in the area of remote sensing and physical resources. Additional meetings are planned for the Socio-Cultural program, and others are proposed for review of new advances in the Physical Modeling and Biology programs as research and development are completed in FY 2006.

Active Adaptive Management Completing Experimental Treatments Proposed in 2002 Plan – Completion of treatments have been identified as a high priority element of the FY 2006 work plan, especially with respect to implementation of the fourth year of mechanical removal of non-native fishes and completion of key sediment experimental flow releases. Although more costly than originally projected, the mechanical removal project has proven to be effective in reducing non-native salmonid populations in the Lower Marble Canyon and Eastern Grand Canyon reaches proximal to the confluence of the Little Colorado River. The FY 2006 work plan is intended to allow completion of this important biological experimental treatment, while also allowing final reports to be prepared and externally peer reviewed on fluctuating-flow strategies for suppression of rainbow trout in the Lees Ferry reach. The plan also allows for completion of the fine-sediment change detection project to finalize work related to monitoring and research related to the November 2004 Experimental High-Flow test. This work includes studies to better document the fate of new sand bar deposits with respect to reworking by wind and verification of a one-dimensional sand routing model.

Expansion of Socio-Cultural Program to Better Reflect Priorities – This theme was seriously embraced by the GCMRC during development of the FY 2006 work plan. The desire to increase the available information related to recreational and culture resources was identified by members of the Glen Canyon Dam Adaptive Management Work Group with the need to complete other research activities, including experimentation. However, the projected costs for these sociocultural new activities forced the Center to recommend limiting activities in some other biological and physical resource areas.

Focused Support for Humpback Chub Actions – Several activities were implemented during FY 2003-2005, related to humpback chub. Some of the proposed actions were deemed to be either heading to completion in FY 2005, or were projects not sufficiently well developed to have been implemented yet. Pending completion of the Humpback chub plan by the Adaptive Management Work Group, the GCMRC proposes that funds for concurrent population estimates be budgeted in future work plans until such time that a final determination is made about whether such work needs to be implemented. If such estimates are not deemed essential to the program, then the funds become available for support of other research and monitoring activities, such as ongoing implementation of experimental treatments.

In the FY 2006 work plan, the GCMRC proposes a balanced fiscal approach to science programming that continues focused research tied to development of a core monitoring plan, as well as continued implementation of experimental non-flow treatments outlined in the 2002 experimental plan. The Center contends that this approach is the most logical strategy to follow until such time that additional research and monitoring plans are developed and adopted for implementation under available funding.

GEOGRAPHIC SCOPE

The geographic scope of the Glen Canyon Dam Adaptive Management Program (GCDAMP) is the Colorado River mainstem corridor and interacting resources in associated riparian and terrace zones, located primarily from the forebay of Glen Canyon Dam to the western boundary of Grand Canyon National Park (Figure 1.1). It includes the area where dam operations impact physical, biological, recreational, cultural, and other resources. The scope of Adaptive Management Program activities may include limited investigations into some tributaries (e.g., the Little Colorado and Paria Rivers). The lateral scope is an issue of ongoing research and investigation to determine where the effects of dam operations are located along the floodplain and where opportunities exist for mitigation of dam operations (e.g., sediment in the Paria River, or humpback chub breeding habitat in the Little Colorado River). The Adaptive Management Program may do research outside the geographic scope defined above to obtain needed information. Such linkages with other areas "should be made on a case-by-case basis, considering ecosystem processes, management alternatives, funding sources, and stakeholder interests," (NRC, 1999:43; Loveless, 2000).

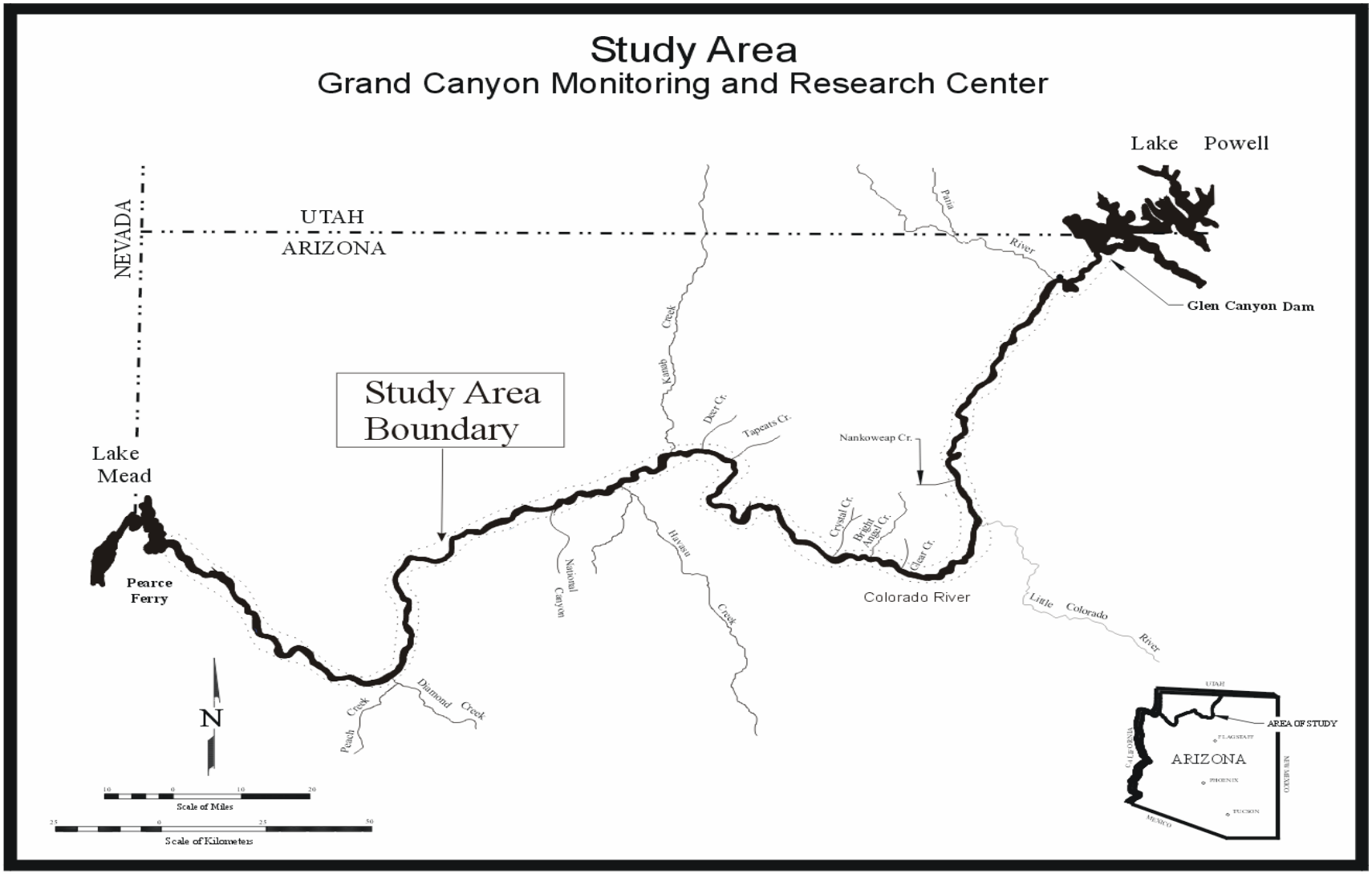


Figure 1.1. Map of the Colorado River Ecosystem (GCMRC Study Area).

GCMRC scientific activities are intended to determine the effects of Record of Decision (ROD) dam operations and other management actions primarily on downstream natural, recreational, and cultural resources of the Colorado River Ecosystem (CRE). GCMRC activities include limited investigations into tributaries (e.g., the Little Colorado and Paria Rivers) and reservoirs (e.g., Lake Powell). The AMWG, in drawing these boundaries on the geographic scope of GCMRC scientific activities, acknowledge that these constraints may inhibit the ability to distinguish the effects of dam operations on CRE resources from other effects. Therefore, scientific information from programs outside the GCDAMP may be needed as a means of strengthening the understanding of the entire CRE. For additional information on programmatic and institutional scope of the Adaptive Management Program, please refer to the AMWG Strategic Plan on the web (http://www.uc.usbr.gov/amp/amwg/02jan17/Attach_06.pdf).

USGS, GRAND CANYON MONITORING AND RESEARCH CENTER

The USGS is the primary science provider for the U.S. Department of the Interior. The scientific nature of the USGS, its national perspective, and its non-regulatory role enable the USGS to provide information and understanding that are policy relevant and policy neutral. The USGS serves the Nation as an independent fact-finding agency that collects, monitors, analyzes, and provides scientific understanding about natural resource conditions, issues, and problems.

The mission of the USGS is to serve the Nation by providing reliable scientific information to:

1. describe and understand the Earth;
2. minimize loss of life and property from natural disasters;
3. manage water, biological, energy, and mineral resources; and enhance and protect our quality of life.

Mission of GCMRC

The GCDEIS (DOI, 1995) directed the Secretary of the Interior, "To establish and implement long-term monitoring programs and activities that will ensure that Glen Canyon Dam is operated in a manner consistent with that of Section 1802. . ." of the GCPA. The mission of the GCMRC
is:

To provide credible, objective scientific information to the Glen Canyon Dam Adaptive Management Program on the effects of operating Glen Canyon Dam under the Record of Decision and other management actions on the downstream resources of the Colorado River ecosystem, utilizing an ecosystem science approach.

Roles and Responsibilities

1. Provide quality, objective science and the use of that science in the adaptive management decision process.
2. Provide scientific information for all resources of concern identified in the "Operation of Glen Canyon Dam Final Environmental Impact Statement."
3. Support the Secretary's designee and the Adaptive Management Work Group in a technical advisory role.
4. Develop research designs and proposals for implementing, by GCMRC and/or its contractors, monitoring and research activities in support of information needs identified by the Adaptive Management Work Group.
5. Coordinate review of the monitoring and research program with independent review panel(s).
6. Coordinate, prepare, and distribute technical reports and documentation for review and as final products.
7. Prepare and forward technical management recommendations and annual reports, as specified in Section 1804 of the Grand Canyon Protection Act to the Technical Work Group.
8. Manage all data collected as part of the Adaptive Management Program. Serve as a repository (source of information) for others (stakeholders, students, public, etc.) in various formats (paper, electronic, etc.) about the effects of operating Glen Canyon Dam on the downstream resources of the Colorado River ecosystem and the Adaptive Management Program.
9. Administer research proposals through a competitive contract process, as appropriate.
10. Manage GCMRC finances and personnel efficiently and effectively.

ENSURING OBJECTIVE, QUALITY SCIENCE

The GCMRC was established to provide objective, high quality scientific information to the Secretary of the Interior and to the AMWG. To accomplish these goals, specific operating

protocols for GCMRC were established.[1] The quality and objectivity of GCMRC research findings is ensured through competition and independent external scientific peer review.[2] All proposals, data, reports, etc., are reviewed by independent, external scientists as well as by the GCMRC science team.

GCMRC SCIENTIFIC ACTIVITIES

The FY 2006 Work Plan describes monitoring and research activities that address the management objectives (MOs) and information needs (INs)[3] of the GCDAMP to the extent allowed under current funding. Long-term monitoring is designed to determine changes in resource attributes. Research is used to improve monitoring, interpret and explain trends observed from monitoring to determine cause-and-effect relationships and research associations, and to better define interrelationships among physical, biological and social processes.

In addition, GCMRC has responsibility for management and dissemination of technical information in the AMP program. Included is development and maintenance of a database management system for archiving data collected as a result of monitoring and research activities, maintenance of a geographic information system for analysis and archiving of spatial data, and a central library for additional archiving and data dissemination activities. A major emphasis is placed on serving digital publications, data, and analytical tools to our stakeholders and the public through the portal of the GCMRC website (www.gcmrc.gov). GCMRC also operates a surveying department to provide consistent, quality, cost-effective support to monitoring and research projects. Finally, GCMRC operates a logistics program to provide cost-effective support to scientific field activities.

PROGRAM DESCRIPTIONS AND STATUS UPDATE

GCMRC operates under an organizational structure focused on the following five program areas, each with a program manager: Physical Science Modeling and DASA, Biosciences, Cultural Resources, Logistics and Information Technology. A program-based organizational structure creates challenges to better integrate monitoring and research activities as stipulated in the GCMRC mission statement (see above).

---

1 Operating Protocols for GCMRC, June, 1996.
2 GCMRC Peer Review Guidelines, October 26, 2001.
3 The MOs and the IN's are currently undergoing revision. This Work Plan references the draft revised MOs. The INs are being revised and they are not included in this document.

Furthermore, the existence of an Information Technology program formed a barrier to integrating the included logistical support-activities (e.g., GIS, survey, database management) into a larger, Center-based framework. In recognition of these challenges, the GCMRC Chief instituted a reorganization of the Center on October 9, 2003. Fundamental changes included combining the Biology and Physical Science programs into a new Integrated Ecosystem Science program, and strategically merging elements of the old Information Technology into the newly constituted science programs. The reorganization was expected to increase the effectiveness of GCMRC, particularly as it relates to the conduct of integrated, or ecosystem science. However, the workload of the Integrated Science Program exceeded the ability of staff to effectively manage for increased integration and productivity. In FY 2005, GCMRC expects to hire a Biology Program Manager to administer that component of the program. The new program numbering system, on the Project Summary Sheets that follow, reflect the reorganization.

PHYSICAL SCIENCE, MODELING AND DASA PROGRAM

The Physical Science, Modeling and DASA Program (Physical) represents the GCMRC's primary support capability for research and monitoring related to the physical elements of the Colorado River ecosystem, as well as development and verification of simulation models related to fluvial processes in the Colorado River. It is also the driving force in designing and achieving science integration between physical, biological and socio-cultural elements of the monitoring and research program. It is also the part of the program that aims to develop and verify numerical modeling capabilities related to predictions of flow, sediment transport, thermal regimes and other critical ecosystem parameters related to fluvial processes. Under GCMRC's new 2004 and beyond, organizational structure (see GCMRC's FY 2005 Annual Work Plan), science integration for the CRE centers primarily around analysis of airborne remotely sensed and ground-based data on the Colorado River ecosystem. The system-wide analyses are facilitated within the DASA (Data Acquisition, Storage and Analysis) and driven by team-based initiatives aimed at acquiring resource data, with integrated objectives for analysis clearly identified prior to data acquisition. Following system-wide, airborne digital data acquisition and storage activities in spring FY02 and FY05, a variety of spatially integrated analyses of sand storage, vegetation and coarse sediment deposits (2002 versus 2004 and 2006) become possible in relatively shorter timeframes owing to the increasing functionality of the GCMRC's Oracle relational data engine. Through a combination of

technological advances in database and airborne positioning methods, as well as a new organizational structure, barriers that have hindered past integration efforts for rapid change detection are being reduced.

Proposed Integration Topics - The growing capabilities of the GIS and DBMS staff, within the DASA, will be focused on integrated analyses in the following areas during FY 2005-2008: 1) Inventory of recreational camping areas throughout the CRE in 2006, as well as changes in these areas with respect to changes in sand-bar area and vegetation between 2002 and 2006, 2) recent changes in system-wide sandbars areas and relationships to return-current channels (backwaters) designated as critical habitat elements related to native fishes early life history between 2002 and 2005, 3) recent changes in the distribution and abundance of shoreline habitat types between 2002 and 2005 relative to distribution and abundance data of both native and non-native fish species of interest, 4) recent changes in fine-sediment storage between 2002 and 2005, relative to the known distribution of archeological preservation sites and other elements of the cultural resources program, 5) recent changes between 2002 and 2005, in the distribution of new coarse-grained sediment deposited by tributary debris flows and stream floods (their impacts to associated camping areas and rapids) and their relationship to the benthic organisms of the ecosystem's food web, 6) integration of historical data relating to Lake Powell and associated downstream trends in critical quality-of-water parameters, such as temperature, suspended-sediment transport, dissolved oxygen, specific conductivity, etc. Additional integrated science topics shall be scheduled and undertaken with the GCMRC in collaboration with its stakeholders and science cooperators as funds allow and needs are identified.

Model Development and Verification - In addition to pursuing integrated science analyses, the Physical Science program will also continue high-resolution monitoring of the system-wide flux of stream flow, quality-of-water and fine sediment through the combined use of conventional and innovative new sensor technologies (Melis et al., 2003; Topping et al., 2004). As initiated in 2002-2004, these new technologies will be further supported by two-way satellite telemetry systems that allow real-time access to suspended-sediment and stream flow data, as well as remote control of automated monitoring systems. Over the past decade, several numerical models have been developed by cooperating scientists to predict the fate of operational releases from Glen Canyon Dam, as well as their influence on downstream resources, such as fine-sediment. Ongoing collection of high-resolution data related to the mass flux of fine sediment, water and other parameters such as

temperature, provide the ability to further refine and verify the existing models, as well as develop new models. Through time, as the various model capabilities are advanced, the Physical Science program intends to work with the Socio-Cultural and Biology program areas to develop additional ecological simulations for the CRE. Advanced modeling predictions can then be used to better focus the planning process for longer-term experimental designs that may be considered for implementation.

Physical Science and DASA Updates - Following, are descriptions and updates on current knowledge related to the individual elements of the Physical Science, Modeling and DASA program area.

Integrated Quality-of-Water Program Upstream Component - Lake Powell

Lake Powell Prolonged drought conditions in the Colorado River Basin and a high test flow in November 2004 have contributed to low Lake Powell elevations. Elevations following November's release were at 3567.4 ft. This elevation is similar to that seen in the 1970's when the reservoir was still filling. Storage in the reservoir was at 36% of live capacity (U.S. Bureau of Reclamation, http://www.usbr.gov/uc/water/crsp/cs/gcd.html) in December 2004.

As the warmer surface layers of the reservoir come closer to the penstock withdrawal elevation, increased release temperatures during the summers were recorded in 2003 and 2004. Release temperatures reached 12°C in September 2003 and 14°C in September 2004, the warmest temperatures observed for that time of year since 1973. Dissolved oxygen levels were at very low levels throughout the reservoir in September 2003 owing to resuspension of deltaic sediments.

The GCMRC long-term monitoring program for Lake Powell continues, with monthly forebay and quarterly reservoir surveys. These surveys consist of the collection of a profile of physical and chemical parameters through the water column, sampling at discrete depths for major ion and nutrient concentrations, and biological sampling for chlorophyll, phytoplankton, and zooplankton at selected stations in the reservoir forebay, main channel, and major tributary arms of the reservoir. Continuous water quality monitors are in place for thermal monitoring in the reservoir forebay and in the reservoir tailwater.

The database (WQDB) for Lake Powell and Grand Canyon water quality is nearing completion and being integrated with GCMRC's Oracle database management system. These data comprise all Bureau of Reclamation, GCES, and GCMRC water quality monitoring

information collected since 1965, representing the entire water quality history of Lake Powell. The consolidation and management of these data make it possible to evaluate the information collected from this long-term effort and make changes in sample collection to achieve a more efficient program. Revisions in major ion and nutrient sampling, plankton sampling, and inflow monitoring are expected during FY2006-2007. Monthly and quarterly provisional data from monitoring trips are posted on the GCMRC website and open file reports for each water year are published. The latter was instituted for WY2003.

The GCMRC receives funding for the Lake Powell Water Quality Monitoring Program from Bureau of Reclamation Operation and Maintenance funds, based on an agreement with the Technical Work Group. Adaptive Management Program funds are not used directly for Lake Powell monitoring. The Bureau provides additional support for model development and technical field assistance. Additionally, reclamation provides laboratory analytical services through a service agreement, eliminating the need for GCMRC to contract directly for these services and reducing its direct funding to GCMRC.

Integrated Quality-of-Water Downstream Component

The Integrated Quality-of-Water Project (IQWP) has two major downstream components. The first component is focused on monitoring and modeling the mass-balance of fine sediment in the CRE. Monitoring of fine sediment is important because 1) sand typically provides the material that accumulates in side-channel eddies and creates sandbars that provide backwater habitat areas for native fish and recreational campsites for river runners, and 2) very fine sediment creates turbidity that was ubiquitous in the pre-dam era and has a significant effect on many ecological functions. The second component of IQWP downstream is focused on characterizing other water quality components of the ecosystem, such as water temperature, oxygen, nutrients, and carbon. This component of the program will have a strong linkage to the newly developing aquatic foodbase initiative.

Fine-Sediment Mass Balance – A return to daily monitoring of the fine-sediment mass balance (i.e. input minus export) in the CRE began in August of 1999. Since then, the project has made significant advancements in the monitoring of fine sediment transport through the use of emerging technologies such as laser diffraction and acoustic backscatter. Results of sand-transport mass balance calculations for the period of fall 1999 through September 2000, show that sand loads

passing the Grand Canyon gage, located 102 miles downstream of Glen Canyon Dam, exceeded total estimated tributary inputs; except during the period of June through August 2000 (Low Summer Steady Flow test), when dam operations were held constant at 8,000 cfs. Sand mass-balance data for October 2000 through November 2001, do show evidence of some accumulation of sand upstream of Phantom Ranch (river mile 87), in response to an approximate 1,000,000 metric ton input of sand from the Paria River in October 2000, in combination with relatively low-flow releases from Glen Canyon Dam throughout Water Year 2001. Additional sand inputs from the tributaries that occurred during September of Water Year 2002, also accumulated in the channel bed under the low-flow operations of September through December 2002. However, preliminary observations during January through March 2003, suggest that experimental fluctuating flows exported 2002 sand inputs from critical reaches above Phantom Ranch. Indeed, mass-balance calculations for Marble Canyon and Upper Grand Canyon (Lees Ferry to Phantom Ranch) indicate that sediment export has exceeded input since August 1999 (Figure 1.2). Further, Figure 1.2 indicates that significant export during the winter experimental fluctuating flows is contributing to the negative mass-balance. Significant tributary inputs during fall 2004, led to an experimental high-flow release from Glen Canyon Dam, as discussed in a subsequent section updating experimental flows.

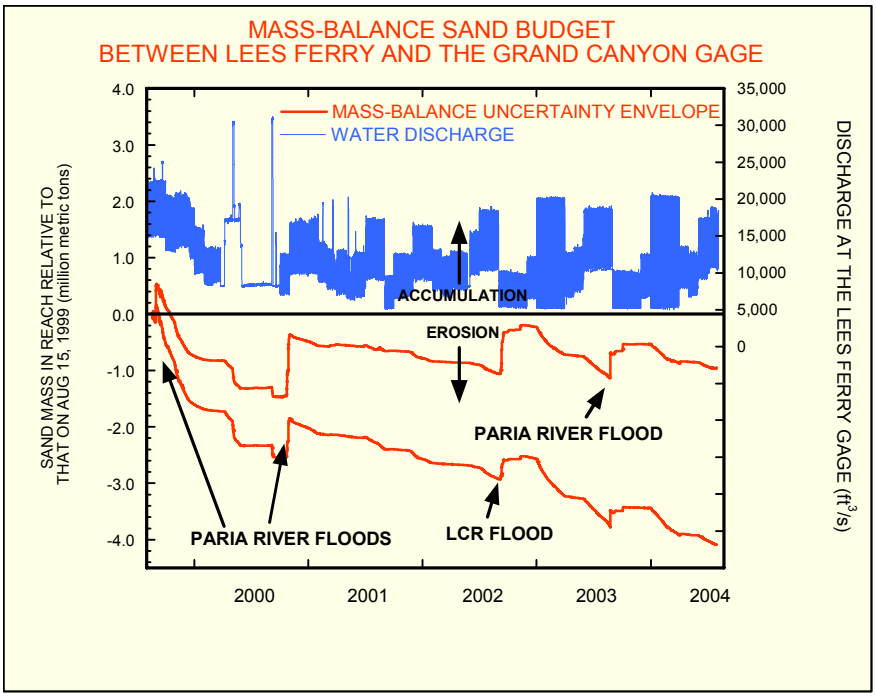


Figure 1.2. Mass-balance of fine sediment between Lees Ferry and Grand Canyon since August 1999 (data are provisional and subject to review and revision).

Existing management actions taken through Water Year 2004, under the Record-of-Decision (ROD) failed to meet even the expectations contained in the Glen Canyon Dam EIS that, compared to the no action alternative, the preferred alternative would result in sand resources in the CRE increasing over time. The basic finding of the mass-balance project team is that downstream transport of new sand inputs occurs much more rapidly than was previously predicted by the Glen Canyon Dam EIS writing team (Rubin et al., 2002). The rapid export of new sand inputs measured during 1999 through 2004 (Figure 1.2), from sediment-starved upstream reaches such as Marble Canyon, indicates that the ecosystem's sand supply does not become progressively enriched over multi-year periods, except during periods when monthly release volumes are at about 700,000 acre feet or lower. If most ROD dam operations prevent new sand inputs from accumulating within the river channel, then re-deposition of new sand inputs cannot occur during occasional controlled floods, termed "Beach/Habitat-Building Flows." Such periodic releases are intended to restore and maintain sand bars that have experienced erosion since dam closure. Suggested alternatives for better conserving new sand inputs include timing the release of bar-building floods to more closely follow significant periods of sand input from tributaries (this alternative was tested in November 2004, as discussed in a subsequent section on experimental flows). Another alternative is to schedule BHBF releases following periods when monthly ROD operations at Glen Canyon Dam consistently reflect below-average basin-hydrology conditions (8.23 million acre feet minimum release annual volumes).

Water Quality Monitoring – Downstream water quality monitoring has been aimed primarily at establishing a robust record of tributary and mainstem temperature data under different flow conditions. More recent protocols attempt to characterize a variety of other parameters that provide information on the ecosystem function, such as dissolved oxygen. Temperature, conductivity, dissolved oxygen, and pH are monitored continuously at Glen Canyon Dam and at several locations on the Colorado River between the dam and Diamond Creek. Temperature is monitored at several other mainstem locations as well as on major tributaries. These data provide information on how these parameters change both in time and space throughout the CRE, aid in the calibration and validation of numerical models, and serve as baseline data for integration with the aquatic foodbase program. As an example, Figure 1.3 shows temperature data collected at Lees Ferry and at the Grand Canyon gage (Phantom Ranch)

during the Low Summer Steady Flows of 2000, illustrating the effects of low flows on downstream warming. Monitoring of water temperatures in backwater areas is also ongoing in order to assess the thermal regime of these critical habitats.

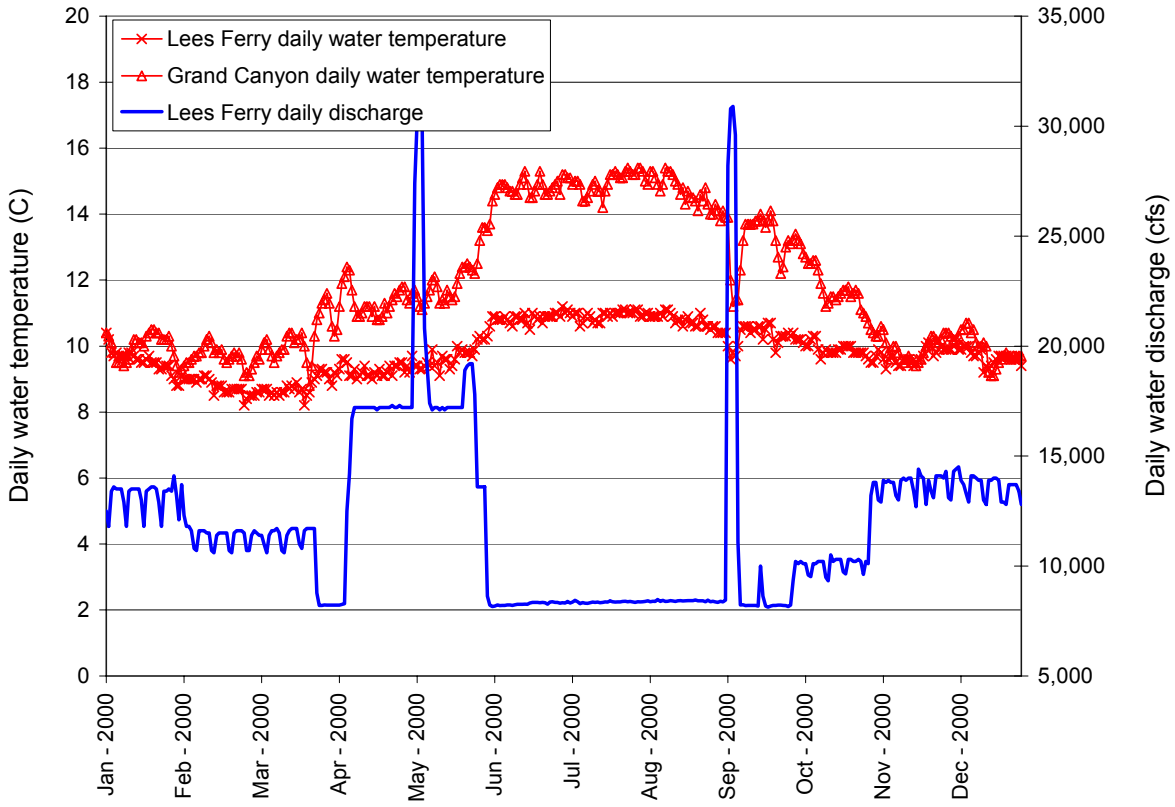


Figure 1.3. Daily water temperature data at Lees Ferry (mile 0) and Grand Canyon gages (mile 87) and daily flows at Lees Ferry during calendar year 2000.

Ongoing data analysis includes the assessment of spatial and temporal trends in the monitored parameters (temperature, conductivity, dissolved oxygen, and pH). In the future, analyses of these data will be integrated with the developing aquatic foodbase program, particularly with respect to analyzing whole-stream metabolism using dissolved oxygen. Protocols are in development for the transfer of collected data into the GCMRC Oracle database in order to facilitate these integrated analyses. A protocol of annual data reporting (as USGS Open-File Reports) is also being implemented in order to give stakeholders and other scientists access to peer-reviewed data as quickly as possible.

Simulation Model Development and Application – Fine sediment transport model development and application has been ongoing since 2003. Two models are under development.

The first model simulates flow and sediment transport in individual eddies and is used to predict how sandbars build under varying flow and sediment supply conditions. The second model uses results from the first model to simulate sediment transport, erosion, and deposition down the Colorado River channel between Lees Ferry and Phantom Ranch. When completed, this model may be used to assess the effects of various dam operations on fine sediment resources in the CRE, and to tailor-design any future high-flow test hydrographs (peak and duration) to maximize effectiveness in bar-building response. The model will be a valuable tool to help managers assess the potential effects of management decisions before implementation.

One of the primary recommendations of the water quality Protocol Evaluations Panel was the development of numerical models of water quality dynamics within the CRE. Numerical models are useful for various applications, including 1) analyzing "what if" scenarios for management decisions (e.g. how would a temperature control device at GCD affect temperatures at various downstream locations?), 2) interpolating both spatially and temporally between collected data (i.e. filling gaps in monitoring records), and 3) isolating the effects of different driving mechanisms (e.g. how do fluctuating flows affect downstream oxygen levels with all other factors being equal?). Beginning in FY05, work was initiated on the development of a water quality model of the Colorado River downstream of Glen Canyon Dam, and this work will continue in FY06. The model is one-dimensional (streamwise) and incorporates results from a previously developed 1D flow model. A modular structure is being implemented so that any generic source/sink term can be added to the model in order to simulate the parameter of interest. The first source/sink term being added to the model is heat exchange between the river and the atmosphere in order to simulate water temperature, since temperature is an important parameter for many ecological processes. Future envisioned additions to the model include DO-BOD relationships, nutrient transport and cycling, and linkage to the fine sediment transport model to assess the effects of fine sediment on other ecosystem processes. The model will be an essential tool for integrated analyses of water quality data in the context of the aquatic foodbase program.

Fine-Sediment and Related Shoreline Habitats

Fine-Sediment Storage Monitoring: Individual sand bar data collected from 1990 through fall 2003, show that sand bars in the actively fluctuating zone (8,000 to 25,000 cfs), and above the 25,000 cfs stage within Marble Canyon (river miles 0-61) have continued to decline

since 1990, despite bar restoration gains achieved by the Beach/Habitat-Building Flow test of 1996, and peak power-plant test flows released in November 1997, and May and September 2000. Although high-elevation sand bars (above 25,000 cfs) below river mile 61 (Grand Canyon) appear to be in somewhat better condition in 2000 versus 1990, than bars in Marble Canyon, deposits within the actively fluctuating zone continue to show decline throughout the ecosystem. The sand-bar time series (1990 through 2002) suggests that the long-term fate of beaches in the upper, critical reaches of the ecosystem will likely be in continued decline under current ROD operations. Beach data collected in fall 2003, show decline in bar conditions at many sites within the first 100 miles below the dam. The most probable reason for the continuing decline of sand bars appears to be related to depletion of the ecosystem's sediment supply. This trend might be reversed if new fine-sediment inputs from tributaries can be managed more strategically using combinations of power-plant operations and BHBF's following tributary floods. Declining beach trends correlate with the findings of the sediment mass-balance project that indicate that new sand inputs from tributaries are transported downstream relatively quickly rather than being retained throughout the river channel and periodically re-deposited on diminishing bars.

Experimental Flows Update – ***Fine Sediment Testing in 2004***

Experimental fluctuating flows from 5,000 to 20,000 cfs were conducted in January – March 2003 and 2004. These flows are designed to disadvantage non-native fish in the Glen Canyon reach, but also have an effect on fine sediment transport. Because of the non-linear nature of the relation between sediment-transport and water discharge, higher peak fluctuations tend to transport much more sediment. Analysis of sediment export using rating curves indicates that the 5,000 to 20,000 kcfs fluctuations export 147 – 241% more fine sediment than Modified Low Fluctuations Flows (MLFF) for a 700,000 acre-feet release month. The high export rate of sediment during these experimental fluctuations is also apparent in the mass-balance plot presented in the previous section (Figure 1.2).

Further experimental flows were conducted in November 2004, in response to medium Paria River inputs during September, October, and November. Between July 1 and November 11, 2004, fine sediment monitoring indicated that between 760,000 and 1,260,000 metric tons of sand had accumulated in Marble Canyon, leading managers to initiate a high-flow test in an

attempt to redistribute this newly supplied sand to high elevation eddies and sandbars. On November 20th at 10 pm flows began to ramp up from 8,000 cfs at Glen Canyon Dam, reaching a peak of 41,000 cfs on November 22nd at 4 am. The peak was maintained for 60 hours and the flow returned to 8,000 cfs on November 25th at 1 pm. High-resolution suspended-sediment and bed material data were collected during the high-flow test, along with pre- and post-high-flow sandbar surveys (ground-based and aerial remote sensing combined with traditional land surveying) in selected reaches throughout Marble Canyon in order to evaluate the effects of the high-flow test on fine sediment resources within the CRE. Data analysis is ongoing with preliminary results expected during the fall of 2005 (see Pennisi, 2004).

Data Acquisition, Storage and Analysis (DASA)

Based on results of the 2000-2003, Remote Sensing Initiative (Davis, et al., 2003) and the success of several automated analysis projects undertaken in FY2003, the GCMRC proposes to refocus many of its monitoring data acquisition and analysis efforts around a common theme entitled, automated monitoring technologies and applications. This approach envisions: (1) adoption of a suite of remote sensing technologies that have either been proven or are very likely to produce terrestrial and hydrographic data of sufficient accuracy to satisfy many of the scientific needs of the physical, biological and cultural resource programs, as well as information requirements of resource managers, and (2) development or adoption of digital analysis routines for automating the extraction and classification of information formatted to the monitoring needs of scientists or cooperators attached to the physical, biological and cultural resource programs and to those of resource managers. This approach is designed to supplement and enhance more traditional scientific data collection and analysis technologies, and, in some cases, supplant them. Airborne and ground-based sensors have joined the ranks of more traditional gauging stations as technologies for monitoring the environment. This approach is adaptive. It recognizes that, while all scientific data collection cannot be automated, many analysis and field-support activities can be. Where applicable, the GIS program exists to provide this support. In this vision, 'storage' is that component of the triad that provides the framework for housing and accessing an expanding digital database composed of traditional and remotely sensed data together with their derived information products.

System-Wide Data Acquisition (Airborne Remote Sensing) - The automated monitoring technologies and applications approach envisions implementation of many findings and remote

sensing technologies recommended to the Technical Work Group in the final report from the remote sensing initiative. The remote sensing technology proposed for 2005 was multi-spectral and panchromatic digital imagery (25 cm and 12.5 cm spatial resolutions) together with digital elevation data (1 meter spatial resolution), whose analysis was automated in 2003 to produce terrestrial vegetation and fine-grained sediment inventories.

Remote sensing accomplishments in FY2002-03 included acquisition of a canyon-wide set of multi-spectral digital imagery and a 1-meter digital elevation model (DEM), a successful test of very high resolution LiDAR within Marble Canyon, and the publication of results from the remote sensing initiative. Several automated products were developed from the multi-spectral imagery. These include: a canyon-wide fine-grained sediment inventory, a camping beach characteristic inventory, and the development of digital topographic cross-sections (based on the May, 2002 1-meter digital elevation model) to support hydrographic modeling. FY2004 accomplishments included: a detailed, canyon-wide vegetation map developed from the May, 2002 multi-spectral digital imagery; acquisition of canyon-wide multi-spectral and panchromatic digital imagery (assuming available funds); and very high resolution LiDAR, hydrographic LiDAR and selected multi-beam sonar to support a final assessment of these technologies as primary monitoring technologies. These data will form the basis of detailed inventories, change analyses and technology assessments that will be produced in FY2006 and beyond.

Terrestrial digital elevation base maps - Prior to 2001, GCMRC had sub-meter accuracy terrestrial topographic maps of approximately 80 miles of the ecosystem in 17 areas of concentrated scientific effort that have been referred to as GIS sites. GCMRC also has similar topographic maps from GCD to Badger Rapid near river mile (RM) 8 derived from our LiDAR evaluation in 1998. In FY2000, the GCMRC collected high-resolution orthophotography and topography of the entire CRE. This dataset provides one-foot resolution geo-referenced and rectified imagery and one meter interval contour maps as well as a four-meter digital elevation model. This data set was delivered, inspected, and incorporated into the GCMRC FTP site (accessible from the GCMRC web page or directly at ftp.gcmrc.gov) in the /data/orthophotos and /data/lidar subdirectories. In addition to sub-meter terrestrial base maps described above, we have high-resolution field surveys of 35 sand bar sites that have been repeated at varying intervals since 1991. The GCMRC has numerous field surveys of vegetation, cultural, and

endangered species habitat such as KAS surveys. Additional sub-meter accuracy terrestrial topographic coverage needs to be obtained for the remainder of the ecosystem.

Hydrographic base maps - The hydrographic mapping program was established for the purpose of producing a sub-aqueous channel map of the Colorado River within the ecosystem. Hydrographic mapping supports several GCMRC scientific initiatives including: streamflow and fine-grained sediment transport, fine-grained sediment storage, streamflows and suspended sediment modeling, advanced conceptual modeling of coarse grained sediment, fish habitat mapping, and measuring changes in morphology and topography of the sub-aqueous canyon ecosystem. The Center currently has low resolution (20 meter transects) single beam base data from GDC to Badger Rapid, and GIS Site 7. Additionally, the Center has single beam data (10 meter square) repeated since 1993 at 35 NAU sand bar sites (Hazel et al., 1999; Kaplinski, 2000), repeated surveys from Paria (RM 1) to Cathedral Wash (RM 3), 4 large pool sites in Site 5 (Wiele, 1998), 5 repeated surveys in RM 42-43 and RM 62-65 to monitor the 1996 flood, and a pre- and post-flood survey on the Lake Mead Delta. High resolution (multi-beam) surveys also exist in the pools from RM 1-3, RM 9-11, 29-42, and 45-68. Additional channel mapping of all the remaining river channel needs to be obtained as control is established. In FY2001-03, hydrographic channel data was collected for approximately 60 additional miles of the CRE. This data were processed in FY2002-03. Additionally, the GCMRC has explored the potential of channel mapping using an airborne LiDAR system with water-penetrating capabilities as part of a sediment augmentation feasibility study.

Mapping Riparian Vegetation - We examined various airborne remote-sensing data that were collected during different seasons within a one-year time frame, with different spatial resolutions (11 cm to 100 cm), and with various technologies (CIR film, CIR CCDs, and multi-spectral data) to determine the relative merits of each data set for mapping riparian vegetation within the Grand Canyon. This study determined that digital, 3-4 band image data using appropriate wavelength bands can provide maps of riparian vegetation communities at a 60-70% accuracy level without field surveys. Field verification and limited surveys can increase this accuracy to about 80% or greater.

Mapping Warm-Water Fish Habitats and Cultural Features – The GCMRC's DASA staff evaluated airborne thermal-infrared (TIR) data that were acquired at 100-cm resolution during maximum solar heating (at 1:30 p.m.) to determine the capability of such data for mapping warm

backwaters and near-shore habitats for fish, in addition to mapping archaeological structural sites and natural springs within the Grand Canyon. Airborne TIR data can provide an instantaneous map of surface water temperature for very large regions, which cannot be obtained by in-situ measurement methods. Detection of archaeological structures requires the use of an airborne TIR sensor that can detect temperature differences as small as 0.1 degrees C, and provide at a spatial resolution of no more than 25 cm. Detection would be optimized by data collection after sunset or just after sunrise. Safety issues after dark and shadows during early morning make such data collections very difficult. Detection of natural springs is better approached using TIR data collected after sunset. The TIR data collected during daylight hours detect only the largest springs, whose existence is already known. Detection of natural springs after sunset can and has been accomplished using rather low-resolution imagery (1-3 meters) because the spring waters spread from their source and present a large area and the spring water is much colder than the surrounding warm, dry ground.

Monitoring Sand-Bar Deposits - The GCMRC evaluated light detection and ranging (LiDAR) and photogrammetric methods for remotely mapping sand bar deposits along the Colorado River to determine if these two remote-sensing technologies for mapping topography could approach the accuracies currently obtained using field survey methods and at a comparable cost, while providing more aerial coverage. Thus far, our studies have determined that LiDAR appears to be a suitable method for rapidly obtaining the topography of bare sediment surfaces over very large regions whereas photogrammetry produces more accurate ground topography in vegetated terrain than LiDAR.

Members of the DASA are further investigating LiDAR and photogrammetry in terms of their ability to map volumes of terrestrial sediments, which does not require knowledge of absolute elevations. In FY2002-03, the Center staff investigated remote-sensing technologies to determine vegetation habitat structures (area, volumes, heights), to map and monitor older river terraces, to map and monitor channel bottom deposits, and to monitor the river water's suspended load and turbidity. In November 2004, LiDAR data was collected for FIST reaches 2 through 7 (Paria River to Palisades) during the steady flow periods before and after the experimental high-flow of 42,000 cfs to capture the pre- and post-flood conditions of those sites. Additionally, the Center is currently planning another LiDAR mission to further monitor the same reaches in May 2005.

The remote sensing initiative was completed at the end of FY2003, and a final presentation on the findings and recommendations associated with the initiative was made to the Adaptive Management Workgroup in March 2005. The final report, completed in fall FY2003, recommends technologies for implementation within all GCMRC program areas (Davis et al., 2003). Remote sensing activities in FY 2005 consisted of digital, multi-spectral data (similar to the system-wide data set from May 2002), collected using state-of-the-art airborne sensors in support of the biological, cultural, and physical science programs at GCMRC. The digital imagery collected in May 2002 has proven to be a definitive data source for hardcopy river atlases in support of field work, in-house spatial database development, spatial analysis and internet mapping applications. The overflight of May 2005 served these same purposes as well as supply an updated dataset for future scientific endeavors.

Data Storage (Database management) - The DASA is the first of three fundamental technologies for consolidating, storing, and distributing data gathered as part of monitoring and research projects at GCMRC. Its purpose is to store all tabular data available in electronic form and to reference additional data that is either not available in electronic form or is not tabular (e.g., digital imagery). The Oracle database engine was selected for GCMRC database development. Oracle is a state-of-the-art data storage and delivery system that can function either as a centralized or distributed database and incorporates a high degree of information technology integration. The Database Management System (DBMS) program is currently working on bringing together years of disparate historical data collected by multiple entities located in databases across the southwest, in an organized fashion and then deliver it transparently to stakeholders and researchers for decision-making and modeling purposes. A key aspect of this work has been integrating Oracle's database management software with the Center's ARC/INFO GIS, so that all tabular data sets can be viewed and queried in a spatial context. This database will continue to serve as the backbone for data management encompassing other DASA components from data storage and analysis to the automated access of CRE information.

Data Analysis (Geographic Information Systems) – The Geographic Information Systems (GIS) Program provides technical support, spatial databases and spatial analysis capabilities to scientists in the physical, biological and cultural resource programs and their cooperators. Monitoring activities within the CRE are inherently spatial in nature, any cross many scientific disciplines. In this context, spatial database integration is an extremely important component of

a successful integrated science program. It provides the framework for canyon-wide ecosystem studies. In combination with canyon-wide remote sensing data, GIS provides an important tool for integrating and analyzing large amounts of site-specific, regional and canyon-wide data in formats that are supportive of scientists as well as resource managers.

Over the past several years, the GIS program has provided many important products and services to scientists and cooperators operating within the GCMRC framework. These have included: spatial database collection, development and integration; field operation and mapping support activities; the development of common spatial referencing systems; and custom GIS programming and analysis for specific scientific projects. Important GIS products have included: a canyon-wide shoreline habitat map; an automated fine-grained sediment inventory and camping beach analysis developed from digital imagery; an automated tool for generating composite terrestrial / hydrographic cross-sections and virtual shorelines in support of hydrologic modeling; and large-scale river map guides.

The GIS program will lead the effort in implementing the automated monitoring technologies and applications approach. This effort is designed to quickly and accurately classify large sets of raster and vector data into monitoring information that are useful to scientists and resource managers. Future GIS efforts will focus on automated analyses of remotely-sensed data in support of specific physical, biological and cultural resource projects and monitoring missions, as well as continued integration of spatial information for scientific analysis and reporting. In FY2003, the GIS program demonstrated that automated processing of multi-spectral digital imagery could be utilized to accurately map vegetation and the two-dimensional distribution of fine-grained sediment deposits above 8,000 cfs on a canyon-wide basis. Techniques will also be developed for automated processing and classification of data acquired from the terrestrial and hydrographic LiDAR missions and existing multi-beam sonar data.

Technical Support Coordination - Integration of support capabilities in the areas of GIS and Remote Sensing is critical to the success of scientific data collection and integration for all of GCMRC's research and monitoring projects. Technical Support Coordination requires effective communication with Researchers, Program Managers and GIS and DASA personnel to facilitate collection and delivery of information that complies with GCMRC Data Standards. Coordination entails evaluation of requests and scheduling of the appropriate equipment,

materials, services and personnel required to implement research activities. Examples of Technical Support requests include:

- Copies of existing map products and aerial photo sets.
- Processing requests to GIS for new map products.
- Scheduling Field Equipment (i.e. Computers, handheld GPS units, digital cameras, etc.).
- Scheduling personnel required to assist with field work.
- Consultation with GIS personnel for recommendations on data collection methods to achieve effective integration with the GIS.
- Consultation with Database personnel for advice on data collection formatting to achieve effective integration with the GCMRC Database.

Additionally, future dissemination of essential information to researchers related to permitting procedures, trip planning and survey and technical support requests will necessitate utilization of the GCMRC web page. Development of a Research Coordination and Support Program web page will include information pages and access to on-line forms to submit requests for scheduling river trips, and survey and technical support. The web pages will be developed in cooperation with the Information Office staff.

BIOSCIENCES PROGRAM

Terrestrial Resources

Terrestrial resources of interest to stakeholders in the adaptive management program include riparian vegetation, riparian breeding birds and waterfowl, invertebrates including Kanab ambersnail, small mammals, reptiles, and amphibians. Recommendations from a protocol evaluation panel (Urquhart et al., 2000) were incorporated into 2001 monitoring and research plans, and portions of this work continue to be evaluated and implemented through 2005.

Through FY05 terrestrial monitoring included a yearly field-based assessment of vegetation cover, species richness and diversity at 60 transect sites along the CRE at discharges of 15, 25, 35, 45, and 60k cfs. The intent of these longitudinal transects at set discharges are to link changes in measured vegetation parameters to operations and climatic patterns. Multi-year data sets through 2003 indicate that operations and the extended drought affect vegetation cover

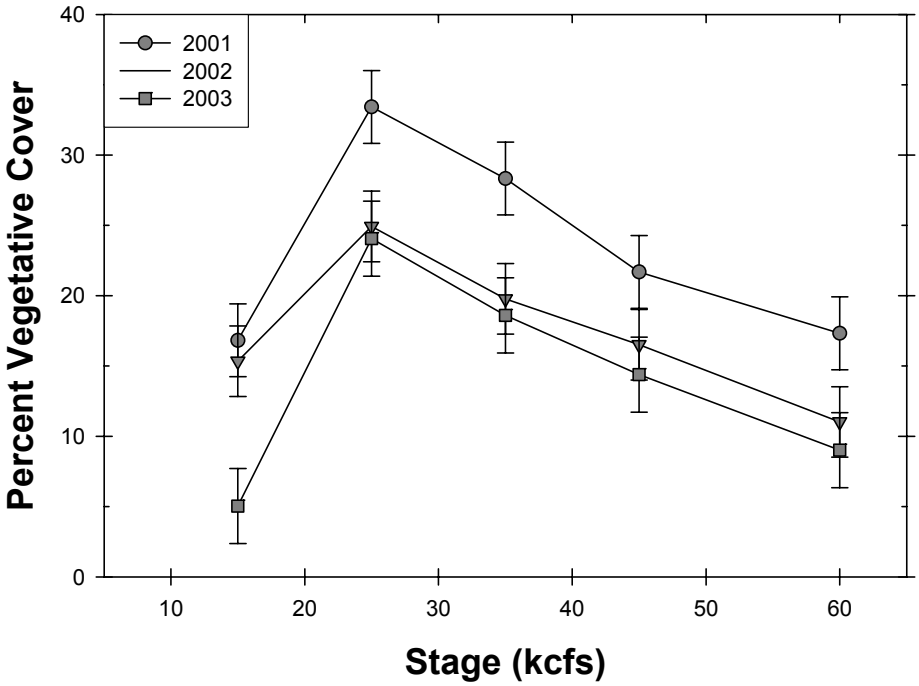


Figure 1.4. Percent vegetative cover at five stage elevation zones between 2001 and 2003. Vertical bars represent +/- 1 standard error. Cover has declined in all zones since 2001. Discharge had the greatest affect on stages from 35k cfs to 15K cfs. Overall vegetation cover within the riparian zone is not dense, though cover is greatest at the 25k cfs zone which corresponds with areas utilized for camping.

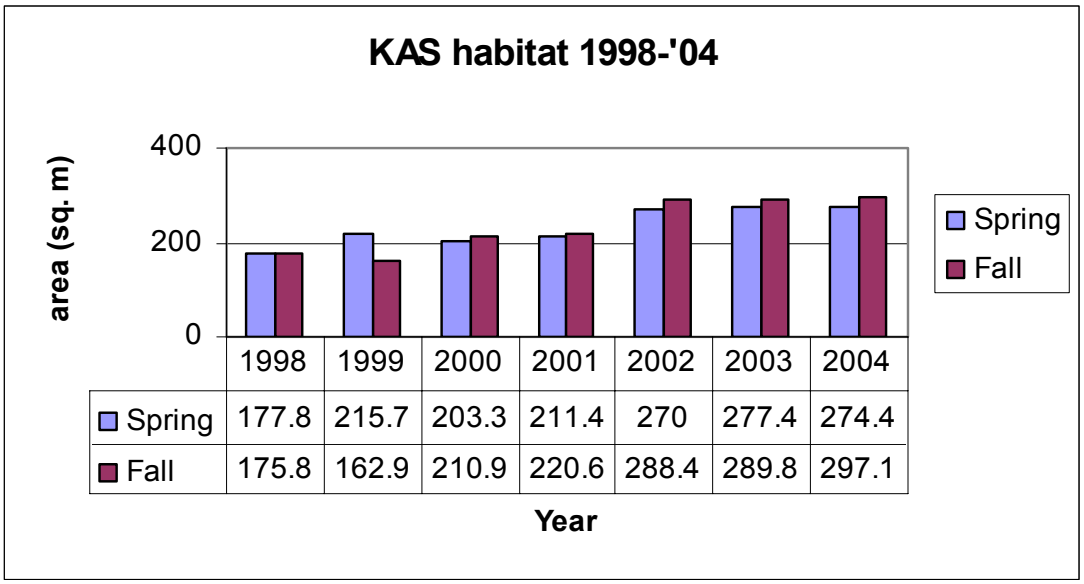
differentially. Operations had a significant affect at stages up to 35k cfs, while climate affected plants at higher discharges (see figure above from Kearsley et al., 2003). Since 2002 cover has declined below 25k stage level possibly as a result of scour associated with winter fish suppression flows (5-20k cfs daily), or as a result of June – August discharges that reached peaks of 18k cfs. Vegetation is sampled in September and it is likely that cover values at the 15k cfs level are associated with summer discharge patterns. The mean wetland score, which most closely tracks operational effects on vegetation and available groundwater, showed no change within zones between years, but an increase in value for all zones compared to 2001 (Kearsley et al., 2002). Again these scores may be associated with either winter or summer discharge patterns. Repeat data collection would determine how these cover and wetland values may be trending relative to climatic and operational changes over time, and illustrates the value of

sustained monitoring. Funding limitations in FY06 do not permit continuation of this ground-based monitoring.

A vegetation basemap initiated in FY2003, to be completed in FY2005, serves as a template for past and future large-scale change detection for core monitoring, as well as for randomized selection of monitoring sites for vertebrates including bird patches. A system-wide mission to acquire a digital dataset, similar to 2002 ISTAR, will be acquired in 2005. This dataset will permit landscape scale change detection for vegetation that is proposed as part of core monitoring. Questions that could be addressed in this avenue of study include camping beach encroachment, status of old high water zone riparian area change, and general riparian vegetation productivity changes at a very gross scale when used in combination with LiDAR and ground truth efforts for canopy heights. These questions and analysis do not address smaller scale species abundance and distribution questions, however.

Riparian breeding birds monitoring, excluding southwest willow flycatcher, will be temporarily suspended in 2006 due to funding limitations. Surveys over the period of 2001-2003 suggest that bird abundances shift between Old and New High Water Zones depending on resource availability. Bird abundance and density, which included migrants and permanent winter and summer residents, was greater in the New High Water Zone ($t=3.4$, $p=0.001$) (Yard and Blake, 2002). Species richness was also higher in the New High Water Zone. This was in contrast to 2001 where species abundance was greater in the Old High Water Zone. The shift in bird abundance between Old and New High Water Zones may be associated with lower abundance and diversity of arthropods or seeds from annual grasses and herbs in the Old High Water Zone related to the drought conditions. Decreases in annual grasses and herbaceous plants was recorded in the 35k-60k cfs vegetation transect plots that incorporate stage discharge level (Kearsley et al 2003), which was part of this integrated monitoring project, These data provide correlational support for density shifts observed among riparian birds between years. Synthesis of invertebrate data will take place in 2004-05 and it is anticipated that trophic level interactions will be more developed by 2006.

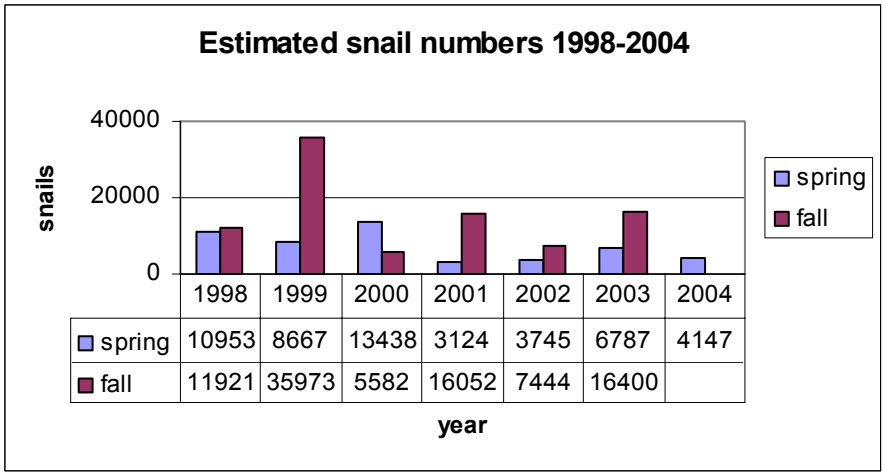
Lastly, Kanab ambersnail monitoring at Vaseys Paradise has continued to follow the protocols begun 1997. Data collection efforts continue at two trips per year: one in spring and one in fall. Population estimates for the snail indicate that the snail numbers vary widely throughout the year (10,000 in the spring to 100,000+ in the fall), influenced by climatic and concomitant habitat variability (SWCA, 1999). Greatest gains in habitat occurred between 2001 and 2002 where snail habitat at Vaseys Paradise increased 6 % in area between spring and fall of 2002. Total surveyed habitat changed from 270.01 m^2 in April to 288.36 m^2 by August 24, 2002.



	1998	1999	2000	2001	2002	2003	2004
Spring	177.8	215.7	203.3	211.4	270	277.4	274.4
Fall	175.8	162.9	210.9	220.6	288.4	289.8	297.1

Yearly average total habitat has increased steadily and significantly since 1998, from 176 m^2 in 1998 to 297 m^2 in 2004 (see figure above). Patch composition has shifted toward more monkey flower and less watercress which may also be an indication of drier soil moisture conditions and fewer disturbances.

Snail Abundances - Estimated snail numbers have not changed significantly since 1998, but numbers have shown a decline to a value of 4147 snails in April 2004. Curiously, while habitat has increased, snail numbers have not had a correlated increase. The lack of increase in



	1998	1999	2000	2001	2002	2003	2004
spring	10953	8667	13438	3124	3745	6787	4147
fall	11921	35973	5582	16052	7444	16400	

snail numbers may be associated with soil moisture and shifts in plant species composition rather than the amount of habitat available. The discharge from the spring at Vaseys Paradise has declined since 2001, the amount of watercress found within the habitat has become reduced, and bighorn sheep have begun to habitually visit and forage on *Carex aquatilus (sedge*) at the springs. These factors in combination may be affecting snail numbers recorded since 2001 (see figure above).

Aquatic Resources

Aquatic resources continue to undergo review of methodologies and historic data. New sampling methods are being incorporated into monitoring the sport fishery, native fish communities, food base, and water quality monitoring. Protocol review panels were held for the water quality program (Ruane et al., 2001), the Lees Ferry trout fishery (Culver et al., 2000) and for the aquatic program (Bradford et al., 2001), which includes the mainstem fishery downstream of Lees Ferry, and the aquatic food base program at a system-wide perspective. Recommendations made for the native and non-native fishery programs have included increasing random sampling efforts, strengthening efforts associated with integration across disciplines and developing modeling efforts. An effective mark-recapture program in the LCR and different stock assessment models for assessing the status and trends of the humpback chub have been developed from this review process.

The water quality and food base resources are in the process of incorporating recommendations into a revised program and will spend 2005 – 2007 testing and evaluating data and sampling methods that are most pertinent to stakeholder management objectives, information needs, and that are biologically informative from a food web perspective. Reviews of the aquatic food base program determined methods and approaches done up to 2002, while informative, were insufficient for monitoring because an understanding about linkages between lower trophic levels and food availability of fish were deemed inadequate to interpret food base in relation to management goals. They identified that further research was needed before a long-term monitoring program existed, because assumed linkages between food base and fishes had not been empirically established.

Food Base Resources

The aquatic protocol evaluation panel had concerns with the lack of empirically established linkages between food base and fishes (Bradford et al., 2001), and identified that a possible consequence of the recent increase in primary and secondary production may differentially benefit non-native species (competitors or predators) over native species. Because of this, additional research and the restructuring of the existing foodbase monitoring program is warranted in light of its importance toward meeting stakeholder objectives. A series of integrated studies will address a number of issues identified by the aquatic protocol evaluation panel (Bradford et al., 2001). Primary focus is on the research and development of an organic budget and foodweb linkage program as an organizational framework to determine whether or not the aquatic food base is limiting, and to determine what organic sources, and where limitations occur within the Colorado River system. This requires multiple approaches: 1) conduct in-stream metabolism and community respiration experiments; 2) quantify organic and inorganic carbon supply and fluxes (decomposition, transformations and residency); 3) based on findings of the organic mass balance research design and effective sampling program having the appropriate sampling locations, methods and frequency for assessing and quantifying organic flux (sources, pools, transformations and movement), and 4) develop a better understanding of foodweb linkages within the spatial distribution of the entire fish community. Downstream water quality parameters will be developed in conjunction with the food base program to define biologically important water quality variables.

Several research projects assessing food-fish linkages have been recently implemented. These include: bioenergetics modeling (Peterson and Paukert, 2003) and diet and predation associated with non-native trout removal project at the LCR (Coggins and Yard, 2003). Following the aquatic protocol evaluation panel recommendations, it is proposed that an organic mass balance project be used as an indicator of system-wide production and export. A request for proposals will be developed during 2005 for this initiative.

Fisheries Resources

The Lees Ferry trout fishery has developed a stock assessment model using historic angling data and catch effort data from past monitoring efforts. The model provides a three-to five-year view of the state of this fishery resource and provides an opportunity to evaluate management strategies associated with this fishery (Speas et al., 2001). The monitoring program that is in place through a cooperative effort between GCMRC and Arizona Game and Fish includes the historic fixed sampling sites and new random, stratified sites based on shoreline type. The program's design is intended to increase sampling areas to better characterize the trout fishery as a whole. Recent data indicate that the fishery is strongly influenced by diel changes in flows and that growth is likely density dependent: The stable flows associated with ROD operations has increased recruitment and the increased numbers of fish has resulted in smaller fish (Speas et al., 2001).

The downstream fishery program has approached the development of a long-term monitoring program in a step-wise fashion to allow for analysis of historic data and to ensure that new monitoring protocols address adaptive management program needs. Steps that have been taken in the downstream fishery program include development of population estimates for rainbow trout and brown trout in the mainstem and for humpback chub in the LCR and its confluence with the mainstem. Stock assessment models of current and historic data suggest that the LCR population of humpback chub has been in decline for over a decade. This downward trend in population abundance is based on an estimated chronic recruitment decline. Multiple hypotheses exist for the apparent recruitment decline including dam operations, tributary flooding, parasitism, predation/competition and mainstem temperature effects. An independent panel of experts was convened in 2004 to review current stock assessment methods. A report from this panel was made available at the January 2004 AMWG meeting. The findings lend

support for the stock assessment models, but did make suggestions regarding additional simulation efforts associated with the model.

Associated with the 2003-2004 adaptive management experiment approved by the Secretary of Interior, a program of mechanical removal of non-native fishes near the confluence of the Little Colorado was implemented in 2003. This work continued into 2004-2005 as recommended. Results from 2003 through March 2004 suggest the efficacy of mechanical removal of non-native salmonids is quite high (>50%), but that immigration of fish back into the removal reaches is substantial. Therefore, frequent removal of non-native fishes is necessary to maintain low abundance.

Experimental Flows Update

In December 2002, U.S. Secretary of Interior Norton approved an adaptive management experiment to be conducted in Grand Canyon National Park. This experiment, recommended by the GCMRC, began in January 2003 and consists of elements designed to provide a better understanding of both sediment and fisheries resources. As part of the current GCMRC Adaptive Management Program, a key objective is to determine whether certain policy actions are improving humpback chub juvenile survival and recruitment. A central part of the fisheries experiment includes reducing the abundance of non-native fishes in a 16.5-mile reach of the Colorado River near the confluence of the Little Colorado River (LCR; RM 56.2-72.7). This experimental manipulation has been implemented in an attempt to better understand interactions between native and non-native fishes, particularly non-native coldwater salmonids and the federally endangered humpback chub.

The Grand Canyon Monitoring and Research Center, at the Direction of the Glen Canyon Dam Adaptive Management Program, began implementation of non-native fish control in the LCR inflow area of the Colorado River in January of 2003 as part of a joint federal action entitled "Proposed Experimental Flows and Removal of Non-Native Fishes." The fisheries objective of this action was to reduce the number of potential predatory and competitor fishes in habitat occupied by the federally endangered humpback chub, *Gila cypha*. The fish control effort uses electrofishing and had three primary purposes:

- determine the efficacy of this technique to reduce and control the number of non-native fishes in critical habitat for the humpback chub,

- assess native/non-native fish interaction by conducting diet and incidence of predation studies on non-native fishes (primarily rainbow and brown trout), and
- reduce the abundance of non-native fishes in the control reach as much as practicable.

Examination of the preliminary results from 2003 and winter 2004 indicate that the January, February, and March of 2003 removal activities suggests a reduction ~88 % in RBT from the initial January abundance (6,570 fish) following the March trip (779 fish). Theses analyses also indicate very little change in the abundance of RBT between the end of the January trip and the beginning of the February trip (~ 7 fish). However, there was an apparent larger change in the abundance of fish between the end of the February trip and the beginning of the March. Monitoring by the Arizona Game and Fish Department during April indicated the abundance of fish in the removal reach was approximately 80% of estimates obtained the previously year. However, removal efforts in July 2003 suggested significant immigration into the removal reach had occurred such that starting abundance estimates in July were approximately 60% of the pre-January level.

Diet analyses are ongoing, but results thus far indicate low rate of piscivory by rainbow trout and high rate of piscivory by brown trout. Increasing hoop net catches of humpback chub through out 2003 and 2004 may indicate a habitat/survival response by HBC following non-native removal. These data reviewed in conjunction with stock assessment information will provide more definitive information regarding these questions.

The success in the first months of the experiment, prompted GCMRC to examine and propose a modification to the original plan for mechanical removal. The modification extended the original area of removal downstream to RM 72.7, adding 7 miles to the area below the LCR. During 2004, removal areas and depletion pass numbers were increased. Four depletion passes in the original reach (RM 56.2-65.7) and 4 depletion passes in only the upper part of the expanded reach (65.7 – 68.5; Lava Canyon to Tanner Canyon) were conducted. This design permits adequate removal efforts to maintain low non-native abundance and an expansion beyond the originally proposed reach. This compromise should strengthen the experimental treatment and increase both the likelihood that a change in HBC survival and recruitment will occur as well as our ability to detect such an increase.

Mechanical removal was continued into FY05 and is proposed in this work plan for a fourth year. It will be implemented as per recommendations from the Adaptive Management

Work Group as approved by the Secretary of the Interior. GCMRC recommends continuing implementation of experimental treatments under the current experimental flows plan for years 3 and 4.

Humpback Chub

The GCMRC reported a continuing decline in the Grand Canyon population of humpback chub (*Gila cypha*) in 2002. Cause for the decline is unknown, but stock synthesis models indicate a lower recruitment for most of the previous 10 years.

In response to concerns about the status of humpback chub, on January 29, 2003, the Glen Canyon Dam Adaptive Management Work Group (AMWG) created the Humpback Chub Ad Hoc Committee and directed that the committee "… will consider actions to implement a comprehensive research and management program for the HBC (humpback chub) … (and make) a recommendation to the AMWG …." The motion that was approved further indicated that the Ad Hoc Committee would consist of AMWG, TWG (Technical Work Group), and GCMRC, and science advisors which would again develop recommendations and report to AMWG at a special session. Meetings of the Ad Hoc Committee were held February 12, March 12, April 1, 21, and 22, and May 6, 2003. Conference calls were held April 16 and 25, 2003

An overview of the status and trend of the Grand Canyon population of humpback chub was prepared by GCMRC for the AMWG on April 22, 2003. That report stated that recent analyses of historical data on humpback chub in Grand Canyon have caused considerable concern, because of uncertainties about the current size of the population and the strong probability that the population has been declining steadily for at least a decade. The most recent assessment model indicates that the spawning population is probably somewhere between 2,000 and 4,000 age-4 and older fish. A different estimate, using the "Supertag" assessment model, resulted in an estimate of 1,100-1,200 adults in 2001. Estimates of the LCR spawning population for 1992-1995 were 2,000-4,700 adults (Douglas and Marsh, 1996). The assessment model also determined a lower level of recruitment (i.e., fish reaching maturity at age-4) over the last decade. The GCMRC report also stated that if recruitment continues to be stable at an average of the 1995-98 rate, the population will likely stabilize at 1,000-3,000 adults.

Recovery goals exist for the humpback chub in the Colorado River Basin, and include all six populations (U.S. Fish and Wildlife Service, 2002). The Recovery Goals provide guidance on recovery of the species, basin-wide, and identify site-specific management actions, and

objective, measurable criteria for achieving recovery. The Recovery Goals identify actions necessary to conserve and recover the Grand Canyon population of humpback chub, as well as the role of the Grand Canyon population in recovery of the species.

A goal of the GCDAMP is to remove jeopardy and assist in achieving recovery goals for humpback chub in Grand Canyon by expanding the population size and reducing threats to the humpback chub. This will be accomplished by (1) expanding the range of spawning and rearing in Grand Canyon for humpback chub, (2) increasing survival and recruitment of humpback chub, and (3) reducing the threat of catastrophic events or unintended consequences that may negatively affect the wild population of humpback chub.

The primary mechanism for expanding range would be to increase the suitability of the mainstem for reproduction and recruitment of humpback chub. This would be accomplished by warming dam releases and providing flows necessary for spawning and rearing.

Until the TCD is approved and constructed, actions such as the translocation of young humpback chub from the LCR into Grand Canyon tributaries and/or mainstem could provide safe refugia for wild fish and possibly expand the current range of humpback chub. To be successful, translocations would need to occur concurrently with non-native control efforts, and with consideration of other factors such as water quality, flows, and tribal concerns. Use of a grow-out facility may be considered to increase growth and survival of wild fish to be translocated. If there are genetic concerns, these would need to be addressed, perhaps through establishing connectivity between the tributary populations and the mainstem population or other actions. These genetic concerns will be evaluated by conservation geneticists.

Increasing Survival and Recruitment of Humpback Chub would be accomplished through a combination of temperature modification, non-native control, dam operations, turbidity management, control of disease and parasites, reduce impacts of scientific and recreational activities, and prevent invasion of new non-native species. These actions include:

(1) Construct and test a temperature control device with the intent of improving spawning and rearing habitat in the mainstem for humpback chub. Providing adequate temperatures for mainstem spawning and rearing may increase other threats such as non-native predation and parasitic infestation.

(2) Control non-native predators and competitors to reduce impacts to humpback chub and other native species. This would also help ensure that any negative impacts from temperature modification would not be on top of an already high predator/competitor load. Additional research may be needed to determine which non-natives have the greatest impact on humpback chub mortality. Mainstem and

tributary control actions would target the most harmful species using a variety of methods. Monitoring of native and non-native fish species must be able to detect changes in these populations that may result from management action, e.g., non-native control efforts and the warming of dam releases.

(3) Use experimental dam releases to reduce mortality of young-of-year (YOY) humpback chub leaving the LCR, particularly prior to operation of the TCD. These actions may include releases that would impound the LCR during periods when young humpback chub are leaving the LCR, stabilize habitat near the LCR confluence, reduce non-native spawning and recruitment, displace or disadvantage non-native fish, and maintain levels of turbidity that reduce feeding behavior of sight feeders in the mainstem. Following construction of the TCD, the focus of dam operations might change to improving spawning and rearing habitat for native fish in the mainstem and controlling the spread of non-natives and parasites.

(4) Control parasites and diseases. Additional monitoring and research is needed to determine the level of infestation and to develop control methods. Warmer dam releases may increase the spread or impact of parasites on humpback chub in the mainstem.

(5) Use other management actions such as sediment/turbidity augmentation to disadvantage non-native fish and provide cover for native species, invasive species management plans, and impact reduction from scientific and recreational uses.

There is a risk of extirpation from catastrophic events in the LCR because it is currently the principle spawning location for humpback chub in Grand Canyon and is occupied by much of the population in a given year. Also, operation of the TCD and other management actions intended to benefit the humpback chub carry the risk of unintended consequences that may negatively affect the humpback chub population.

The top priorities to protect against such risks are (1) expand the range of the population both above and below the LCR confluence (both mainstem and tributaries) so that a catastrophic event is less likely to negatively affect the population, (2) develop and implement an action plan to alleviate threats that originate in the LCR watershed, and (3) establish a captive breeding population for restoring the Grand Canyon population in case of extirpation.

A genetics management plan should be prepared that guides preservation of the genetic diversity of the humpback chub in Grand Canyon. Developing a captive breeding population needs to follow this peer-reviewed comprehensive plan as well as USFWS policy on controlled propagation. Developing the broodstock should not compromise the viability of any extant aggregations (i.e., it may be appropriate only to collect gametes or YOY from the mainstem aggregations). Gametes, YOY, or adult fish may be collected specifically for a new captive breeding population following the comprehensive plan and genetic analysis. The disposition and

use of the existing Willow Beach population must be determined, and may include research or a portion of a founder captive breeding population.

A total of twenty individual projects were identified and rudimentary work plans developed by the HBC Ad Hoc Committee. Those projects will be or are being implemented by GCMRC, its contractors and/or other agencies participating in the GCDAMP. The projects scheduled for FY06 are identified as Humpback Chub Action (HCA) in this work plan.

SOCIO-CULTURAL RESOURCES

The Sociocultural Program has traditionally been a stand alone program within GCMRC's organizational structure. In GCMRC's new organization structure, the program's independent status has been maintained, but the research and monitoring initiatives of the program have been realigned with GCMRC's over-arching integrated science framework. Under GCMRC's new organizational structure and approach, research and monitoring projects conducted in support of sociocultural program needs will be coordinated and integrated with ongoing research and monitoring activities in the Integrated Science Program. Data collected through the sociocultural program's research and monitoring projects will be stored and analyzed using the Oracle database engine and GIS spatial positioning technologies, allowing impacts of dam operations on cultural components of the Colorado River Ecosystem to be evaluated and analyzed in conjunction with physical and biological elements.

In the past, GCMRC's sociocultural program has been defined in terms of three program elements: cultural resources, recreational resources, and socioeconomics. In reality, these program elements are closely interrelated. For example, recreational campsites are essentially the modern equivalent of prehistoric archaeological sites, in that they are places preferentially selected for human activity according to the dictates of the culture currently making active use of the Grand Canyon river corridor. Values attached to traditional cultural places by Native American communities have counterparts in the values attached to beaches, rapids, fishing holes, and trails by modern recreational (angler and whitewater boating) communities. While the specific, culturally-determined values associated with particular places in the CRE may be very different, the fundamental concern with protecting specific place-based attributes and the river corridor as a whole from adverse effects of dam operations is similarly focused on retaining the intrinsic values of places that foster and perpetuate a community's sense of identity and tradition.

There are specific legal obligations and regulations that pertain to historic cultural resources deemed eligible for listing on the National Register of Historic Places; these legal mandates require that certain classes of cultural resources be treated and managed in accordance with regulatory guidelines and standards promulgated by the Secretary of Interior. The Bureau of Reclamation has primary responsibility for managing and treating National Register-eligible cultural resources within the CRE for the purposes of meeting the legal requirements of Section 106 of the National Historic Preservation Act. BOR fulfills its Section 106 responsibilities through conforming to the stipulations of a Programmatic Agreement with the the Advisory Council on Historic Preservation. The Arizona State Historic Preservation Office, National Park Service, and six Native American Tribes are also signatories to this agreement. In the past, GCMRC has assisted the BOR and PA signatories with fulfilling their Section 106 obligations through contracting required studies, organizing review panels, and conducting protocol assessments. The GCMRC sociocultural program has also addressed the cultural resource needs for research and monitoring that fall outside the purview of the PA and relate directly to the mandates of the Grand Canyon Protection Act. Beginning in FY06, GCMRC will oversee an integrated cultural resource monitoring program that meets both the needs of the PA program and NPS for basic archaeological site condition information, while also meeting the needs of the AMP for information specific to effects of dam operations and cause-and-effect relationships among the various factors and processes contributing to current cultural resource conditions in the CRE.

Due to the need for continuing consultation with the Native American tribes who have a long-standing affiliation with the landscape and resources of the Grand Canyon, and because of the unique trust responsibilities of the federal government in relation to Native Americans, GCMRC's sociocultural program involves more than implementing and directing cultural resource-related science projects. Therefore, the sociocultural program has retained its independent status within the new GCMRC organization, while at the same time moving towards increased levels of integration with the other science programs.

Cultural Resources - Cultural resources of interest to the AMP along the Colorado River corridor include National Register eligible archaeological sites and traditional cultural places, as well as non-eligible resources of traditional cultural importance such as springs, landforms, and traditionally used plants and animals. In keeping with the stated purpose of the Grand Canyon

Protection Act (Section 1802) to "operate Glen Canyon Dam in … such a manner as to protect, mitigate adverse impacts to, and improve the values for with Grand Canyon National Park and Glen Canyon National Recreation Area were established**,"** the GCD-AMP seeks to ensure the *in-situ* preservation of cultural resources with minimal impact to the integrity of those resources. When *in-situ* preservation is not possible, data recovery through excavation or other mitigation measures as appropriate may be implemented. GCMRC works with the signatories to the Programmatic Agreement for Cultural Resources and their designated representatives, as well as other stakeholders in the AMP, to help devise monitoring and research projects that will assist in the preservation and treatment of National Register eligible properties. In addition, GCMRC is concerned with devising and implementing monitoring and research projects that address the non-eligible resources of traditional importance to Native American tribes who have cultural affiliation with the Grand Canyon.

Since 1992, cultural resources have been monitored by National Park Service archaeologists and by tribal representatives (Leap et al., 2000). The cultural resource monitoring work conducted to date has primarily been carried out in fulfillment of the Programmatic Agreement requirement to provide information for use in developing a long-term Historic Preservation Plan. The PA-driven monitoring activities typically have included repeated visits to archaeological sites, using repeat photography and qualitative observation to track changes in resource condition. Tribal assessments of traditional cultural resources employ many of the same techniques used in monitoring archaeological sites: repeat field visits, repeat photography and qualitative observations recorded on forms. Tribal assessments of the overall "health" of the ecosystem are generally based on subjective assessments grounded in traditional perspectives. Cultural resources are monitored routinely and during high flow events. Beginning in FY06, monitoring of cultural resources in the CRE will be redirected to focus on the specific requirements of the Grand Canyon Protection Act, in addition to providing basic condition information to meet the requirements for monitoring under the PA. The former PA monitoring program will be realigned and redesigned to generate data that will improve understanding of the effects of dam operations on these highly valued and largely non-renewable resources and to provide information to the AMP that will be useful in formulating recommendations to the Secretary of the Interior about managing dam operations so as to "protect, mitigate adverse impacts to, and improve" the cultural resource values in the CRE.

Many of the archaeological resources along the river corridor are contained in the sediment deposits that form alluvial terraces. Since the completion of Glen Canyon Dam, the sediment resource has declined. The alluvial terraces where many archaeological sites are located continue to erode. A system-wide method for regenerating the river terraces and redistributing sediment has been identified as an essential component to maintaining future integrity for cultural resources (Balsom and Larralde, 1996).

Previous Cultural Resource Investigations: During the past five years, GCMRC implemented and saw to completion the following projects: a synthesis of data collected by the NPS and Tribal groups (Neal et al., 2000), mainstem flow and deposition modeling (Wiele, 2003), and development of a geomorphic model for predicting the susceptibility of archaeological sites to erosion (Thompson and Potochnik, 2000), and preparation of a cultural resource research design for the river corridor (Fairley, 2004).. The data synthesis report (Neal et al., 2000) identified crucial data gaps in previously collected data. Wiele's (2003) stage flow and deposition modeling project provided information on estimated sediment deposition at selected archaeological resource locations, given particular water releases and modeled sediment loads. The geomorphic model by Thompson and Potochnik (2000) attempted to distinguish erosional processes that are related to dam operations versus naturally-occurring processes. Also in FY2000, a cultural resource protocol evaluation panel (PEP) was organized. The panel's report (Doelle, 2000) provided GCMRC and USBR with a series of recommendations for program coordination and future activities. The work activities undertaken since 2001 have been driven by the PEP recommendations.

New initiatives implemented by GCRMC in the last few years, following recommendations of the 2000 cultural PEP, include a project to evaluate the effectiveness of check dams as a mitigation strategy to slow erosion at archaeological sites, and a comprehensive research design for the cultural resources in the river corridor.

The check dam study was initiated in FY01, and a final report was completed in November, 2003. The results of this project (Pederson et al., 2003) suggest that check dams are effective if they are situated appropriately, use appropriate materials (brush appears to be more effective and less damaging than rock checks), and are continually maintained. Another related goal of this research initiative was to test the accuracy of photogrammetry as a tool for detecting geomorphic changes at archaeological sites. Pederson et al. (2003) concluded that errors

associated with low-level, high resolution photogrammetry are too great to detect meaningful changes in arroyo depths and nick point migration at the level most desirable for tracking erosion at archaeological sites (less than 20 cm vertical change); however, they noted that newly developed remote sensing technologies such as LiDAR may be able to provide remote data with the necessary accuracy.

Another cultural PEP recommendation that was implemented in FY2002 involved the preparation of a comprehensive research design to guide future research and monitoring initiatives in the river corridor. The research design was identified by the PEP as a key component of the Historic Preservation Plan mandated as a stipulation of the current PA. Although originally intended to serve the specific needs of the PA program, GCMRC expanded the scope and purpose of the research design to include a framework for researching and monitoring the full spectrum of cultural resources found within the CRE, in order to meet not only the requirements of the National Historic Preservation Act but also the broader mandates of the Grand Canyon Protection Act. A draft version of the research design was submitted to GCMRC and reviewed by independent scientists and PA signatories in spring, 2003; the final research design was published in 2004 (Fairley, 2004).

Recent and Ongoing Cultural Resource Investigations: Current resource monitoring of archaeological and traditionally-valued resources indicate that archaeological resources continue to be impacted by physical processes such as surface erosion and gullying in both the Grand and Glen Canyon areas. In the CRE, some surface erosion is clearly due to natural processes that are unrelated to dam operations; however, other sediment loss from archaeological sites is believed to be related to dam operations. The contributing effects of dam operations to the ongoing erosion of the river corridor's alluvial terraces (where many archaeological sites) are located remains uncertain and a issue of continuing controversy. Furthermore, the contributing effects of visitor use to the erosion of archaeological resources have never been systematically evaluated, although a relationship between human recreational activities and soil compaction and erosion is known to exist.

A new cultural resource research project that was initiated in FY2003 is designed to track the effects of aeolian transport of fine sediment on the preservation of archaeological resources in the CRE (Rubin, 2003). This research project is one of the integrated research initiatives being conducted as a component of Fine Sand-Storage (FIST) Monitoring in FY04-05. (See

Project A.2 in this document for more details). In FY06, the Cultural Program hopes to continue this aeolian study with one year of additional funding.

In November 2004, a high-flow experiment was conducted to test a variety of hypotheses that resulted from the 1996 Beach Habitat Building Flow. The 1996 BHBF presented an opportunity to study the effects of high flow discharge from Glen Canyon Dam on alluvial terraces and margin deposits along the river corridor. The flow was expected to provide system-wide mitigation to most cultural sites in the Colorado River corridor through the accumulation of additional sediment. The overall findings of the cultural resources studies strongly suggested that the 45,000 cfs BHBF flow had either no effect, no adverse effect, or a beneficial effect on cultural resources (Balsom and Larralde, 1996.) These findings lent support to the original contention that beach habitat-building flows above power plant capacity could offer system-wide mitigation for cultural resources. One location in the Glen Canyon reach~~,~~ did experience loss of sediments in a way that, in the long run, could be detrimental to cultural resources(Balsom and Larralde, 1996), but three of the four study areas gained sand, and some of the newly deposited sand appears to have been redeposited over subsequent months at higher elevations through wind action (Hazel et al. 2001.) The experimental high flow of November, 2004 provided an opportunity to reassess the potentially beneficial aspects of bar-building flows near archaeological sites. One location in the Palisades area that had been studied in 1996 was remapped both before and immediately following the 2004 experimental flow, and we will be continuing to track the fate of sand deposits in that area by means of repeat mapping through FY06.

Recreational Resources - Recreational resources encompass several diverse, tangible elements: the blue-ribbon trout fishery at Lees Ferry, the challenging whitewater rapids in the Colorado River, and camping beaches in Grand Canyon. Recreational resources also encompass experiential attributes, such as opportunities to experience solitude, natural quiet, and physical challenges in a wilderness-like environment. Recreational issues of specific concern to the GCMRC sociocultural program include changes in the size and availability of camping beaches due to dam operations, changes in the quality of recreational experiences within the CRE (including trout sport fishing, recreational river trips, and wilderness-dependent recreational opportunities) due to effects of dam operations, plus the economic impacts to the recreation industry from varying flow regimes. GCMRC has supported studies in all of these areas.

Previous Recreation Investigations: Sand bars serve as campsites for rafting groups and are highly valued by the boating public based on size, boat mooring quality, wind protection, access to side canyon hikes, scenery, and shade. Historically, these beaches were replenished annually by sand and silt transported by the river during spring runoff. Approximately 93% of this sediment now settles out in Lake Powell, so the beaches downstream are eroding due not only to the river's clear, sediment-free flows (Kearsley et al., 1994), but also due to the way that the remaining 7% of the sand supply is currently being managed through dam operations. Camping beaches are also being eroded through gullying induced by monsoon rainstorm runoff. Due to the lack of periodic, sediment-enriched floods, these increasingly degraded beaches are not being replenished. Since dam operations began in 1963, most pre-dam beaches have become considerably smaller, while some have disappeared completely. Another factor contributing to the loss of campable areas in the CRE is vegetation encroachment, which is a direct result of the lack of frequent scouring floods under current dam operations. The size and availability of camping beaches is directly tied to visitor experience parameters in that the decreasing size, abundance, and distribution of campsites constrains the visitor carrying capacity of the CRE and may lead to crowding or reduction in visitor access, thereby creating adverse impacts to visitor use values in the CRE**.**

In 1994, change in campable area from previous studies was analyzed using aerial photographs (Kearsley et al., 1994). This analysis revealed that loss of campsites was an ongoing process. The researchers noted that not all sand bars responded in the same manner to flows and vegetation encroachment, and that campsite availability in critical reaches (Marble Canyon, the Inner Gorge, and the Muav Gorge) had decreased the most. Effects of the 1996 controlled flood at selected campsites were also evaluated, and it was found that the increase in the number and size of campsites was of short duration (Kearsley et al., 1999). The post-BHBF data indicated that while floods temporarily increased campsite number and size, the beneficial effects to campsites were temporary, and that campsite size rapidly degenerated to pre-BHBF levels and then continued to erode more slowly. Although the effects of the 1996 artificial flood were temporary, periodic “floods” above power plant capacity appear to be the only feasible means of depositing sediment and rejuvenating camping beaches above normal fluctuations (Kearsley et al., 1999).

One previous study assessed recreational preferences relative to dam-controlled flows and quality of camping opportunities (Stewart et al., 2000). The study concluded that users of the Colorado River were relatively unconcerned about impacts of fluctuating flows, had strong concerns (generally positive) about impacts of spike flows, and strongly preferred sandy beaches with shade (especially from trees) for camping.

Recent and Ongoing Recreation Investigations: Recent GCMRC studies have assessed camping beaches, trout fishing activities, and recreational river running in terms of visitor experience issues and safety concerns associated with varying flow levels. Low Steady Summer Flows in summer 2000, provided data on impacts to recreational experiences (Jonas and Stewart, 2002), travel rates and safety (Jalbert, 2001) and economic impacts to concessionaires (Hjerpe and Kim, 2001). Final reports have been received for all projects except the safety study.

Annual monitoring of 31 campsite areas is on-going as part of the FIST. Interim results from this monitoring effort indicate that camping areas continue to erode steadily. However, research results also suggest that erosion can be offset by flows greater than power plant capacity combined with adequate sediment supply (Hazel et al., 2001). A more complete discussion of sediment monitoring is found in the previous sediment resources section for fine-sediment storage and sand bar monitoring.

In addition to the quantitative evaluation of beach size, camping beaches are also being monitored by repeat photography carried out by volunteers working for the Grand Canyon River Guides through the Adopt-A-Beach (AAB) program. Initiated in 1996, the Adopt-A-Beach effort relies largely on volunteer contributions of commercial guides to provide qualitative and anecdotal information on changing beach conditions. The program relies on repeat photography taken from established photo points, supplemented by the guide's observations. The results of the AAB monitoring effort supplements the quantitatively derived information derived from the campsite surveys. The FY04 AAB report generally supports findings of the most recent beach surveys (Kaplinski et al., 2004) that campsite areas are generally declining due to both loss of sediment from the beaches and encroachment of vegetation.

An analysis of past campsite assessment and monitoring protocols used to qualitatively and quantitatively assess changes in beaches (sand bars) and detect area and volume changes was finalized in December 2003 (Kaplinski et al., 2003) One recommendation of this assessment effort is that GCMRC should convene a panel of recreational experts to assess the

effectiveness of current approaches for monitoring visitor use values over the long-term. This recommendation is being implemented through organizing a recreational PEP review in spring, FY05. In addition, the researchers point out that despite 30 years of monitoring human and dam-related impacts at campsites, we lack a comprehensive inventory of campsites in the river corridor. A campsite monitoring program proposed for FY06 will rectify this inventory deficiency, and at the same time, bring together various pieces of the current recreation monitoring program into a single, more unified program.

RESEARCH COORDINATION AND SUPPORT PROGRAM

Implementation of the GCMRC mission to provide credible, objective scientific information to the AMP begins with effective coordination of all technical and logistical support of research activities. The Research Coordination and Support Program staff functions as a team to facilitate collaboration with the Integrated Science and Cultural Programs through effective communication with Program Managers, PI's and the Technical Support Services. The program encompasses the integration of 5 elements:

- Permitting
- Library Operations Coordination
- Survey Support Coordination
- Technical Support Coordination
- Logistics Operations

Program Staff address each of these elements in assessment of support requests from researchers to determine which tools and processes will best facilitate the most effective collection and delivery of information from research projects. Through the combined effort of the program elements the process of research support is executed as a complete and fully integrated support service. The process is initiated in the proposal review and permitting stage, continued through the support coordination stage and completed with information delivery. The process acts as an accountability checkpoint, failure to meet agreed data collection and delivery standards is addressed immediately and corrective solutions are sought to avoid any delay in project completion.

Permitting-Research projects supported by the GCMRC must hold all required permits in compliance with Federal, State, Tribal and Local Agencies in which project activities are conducted and accessed. Research activities conducted within Grand Canyon National Park and

Glen Canyon National Recreation Area require National Park Service **Research and Collecting Permits** and **Access Permits** for all river launches, back country use, over flights, and media (filming) production. All permits acquired for GCMRC-supported projects are processed and submitted through the Research Coordination and Support Program. Copies of all approved permits are kept on file in the Research Coordinator's Office.

All Investigators, Permitees, and project cooperators are responsible for compliance with the regulations and restrictions of their Research and Collection Permit. All trip participants are expected to comply with all GCNP Commercial Operating Requirements while participating on research trips. All PI's and their designated Permitee are required to sign a Research Use Affidavit/Notice of Adverse Actions and Penalties Form which specifies potential penalties for violations of permit conditions. **Failure on the part of investigators or their representatives to adhere to Park and Permit Regulations may result in withdrawal of their permit and other penalties.**

- **Research and Collecting Permits**-Researchers submit project proposals and all other required information (guidelines available on NPS web site) to the GCMRC Research Coordinator. Proposals are distributed externally for review in accordance with the GCMRC Peer Review Guidelines and Protocols. Internal review is completed by Program Managers, support coordinators, and are submitted to the GCMRC Chief for final approval. Finalized permit information is then submitted to the NPS for final review and approval. **NPS Research and Collecting Permit applications require 90 days for processing.**

- **Access Permits**-Researchers holding approved R & C Permits submit a Trip Request Form to the Research Coordinator 60 days in advance of their planned research activity. This form includes request for logistical and support services and all information required for an NPS access permit application. **NPS Access Permit applications require 45 days for processing.**

Library Operations Coordination **-** Interaction with Library Operations is a vital component in the success of the support of GCMRC's monitoring and research projects. Coordination with Library Operations facilitates the support of research activities in two key aspects:

1. The Library provides a centralized repository for hard copy information such as books, reports, maps, photography, and videos. A fundamental function of the library is to provide funded researchers access and use of these library's materials unique to the GCMRC collection.

2. The Library has also implemented a consistent peer review process to help ensure the quality of scientific projects conducted by the GCMRC. The Peer Review Protocols developed and administered by the library are utilized in the NPS permitting process for external review of project proposals prior to submittal to the NPS Research Office for review and approval.

Survey Operations - The long term monitoring objectives of GCMRC require positions and elevations for past, present, and future spatial datasets. The GCMRC Survey Department's mission is to provide survey support for 1) collection of these spatial measurements and, 2) referencing the spatial data collected in the Colorado River ecosystem to the primary control network. The survey department is also responsible for establishing and maintaining the geodetic control network in Grand Canyon. The geodetic control network serves as the foundation for all spatial measurements necessary for long term monitoring. This control network also serves as the spatial framework for the Geographic Information System (GIS). The referencing of spatial data must be consistent in order to perform accurate change detection. All measurements collected for studies approved by the Adaptive Management Program are archived for quality assurance, quality control, network adjustment, and database integration.

The survey department provides network control point coordinates and error estimates, QA/QC for remote sensing, topographic and hydrographic maps, and the additional manpower necessary to collect these data. The survey department staff also incorporates historical datasets that had been previously referenced to superceded or local control coordinates into the CRE database. This integration requires translation and rotation of the instrument and reference azimuth stations to match the most current coordinates, which reference the primary geodetic control network.

The survey department is familiar with data collection and processing of topographic, hydrographic, and geodetic data. Specific equipment available to researchers includes static, kinematic, and Real Time Kinematic (RTK) Global Positioning Systems, single-beam and multi-beam hydrography, acoustic Doppler sensors, laser scanners and conventional survey equipment. The Survey coordinator assesses the level of survey support required to efficiently implement individual studies and evaluates and schedules equipment and personnel requests.

Technical Support Coordination - Integration of support capabilities in the areas of GIS and Remote Sensing is critical to the success of scientific data collection and integration for all

of GCMRC's research and monitoring projects. Technical Support Coordination requires effective communication with Researchers, Program Managers and GIS and DASA personnel to facilitate collection and delivery of information that complies with GCMRC Data Standards. Coordination entails evaluation of requests and scheduling of the appropriate equipment, materials, services and personnel required to implement research activities. Examples of Technical Support requests include:

- Copies of existing map products and aerial photo sets.
- Processing requests to GIS for new map products.
- Scheduling Field Equipment (i.e. Computers, handheld GPS units, digital cameras, etc.).
- Scheduling personnel required to assist with field work.
- Consultation with GIS personnel for recommendations on data collection methods to achieve effective integration with the GIS.
- Consultation with Data Base personnel for advice on data collection formatting to achieve effective integration with the GCMRC Data Base.

Additionally, future dissemination of essential information to researchers related to permitting procedures, trip planning and survey and technical support requests will necessitate utilization of the GCMRC web page. Development of a Research Coordination and Support Program web page will include information pages and access to on-line forms to submit requests for scheduling river trips, and survey and technical support. The web pages will be developed in cooperation with the Information Office staff.

Logistics Operations - The GCMRC provides complete logistical support for 35-50 research, monitoring and administrative river trips through the Grand Canyon annually. These trips range in length from 7 to 21 days and from 4 to 36 people in size. Trips are comprised of a variety of motor and oar powered boats operated by contracted boat operators. Projects operating in the Glen Canyon reach of the Colorado River (Glen Canyon Dam to Lee's Ferry) are supported by a variety of motor powered boats operated by GCMRC researchers and contracted boat operators. Additionally, research activities on the Little Colorado River and at other locations outside of the Grand Canyon National Park boundaries are supported by helicopter services contracted with the Bureau of Reclamation. Ground based support for other research activities outside of the river corridor are also coordinated with the use of GCMRC vehicles.

The GCMRC uses a method of supporting trips in which government owned boats and river logistical equipment are used in conjunction with a contracted vendor who supplies

Technical and Logistical Boat Operators. A concerted effort is made to match PI's with the best possible Boat Operators for their particular study. Food packs, trip supplies, and equipment are organized, packed and maintained at the GCMRC warehouse. Put-in and take-out transportation is provided with the use of GSA leased vehicles and contracted shuttle drivers.

This logistical approach has evolved since the GCES phase to allow a detailed overview of trip particulars that most influence cost and efficiency, ultimately giving the GCMRC control over trip costs and productivity. Effective communication with PI's and sensitivity to and awareness of the challenges they face in implementing their studies enable the GCMRC to offer more customized (and therefore more cost-effective and productive) logistical support than other support strategies utilized previously. Retaining control over the process of supporting trips also facilitates compliance with NPS regulations and allows greater control over issues sensitive to the general public and the "recreational river community."

The trip planning and scheduling process begins in the fall when the Logistics Coordinator, in cooperation with contracted PI's, Program Managers and the Research Coordination and Support Staff work together to generate a draft schedule of trips for the fiscal year. The schedule includes; launch and take-out dates, numbers of personnel and specific boat and boat operator requests for each trip. Researchers must submit a Trip Request Form a minimum of 60 days prior to the scheduled launch date. This form provides information for two purposes: 1) determine and schedule logistical and support services and 2) complete a GCNP River Trip Application in order to meet the GCNP 45 day deadline for submitting access permit applications.

The Logistics Budget is distributed to GCMRC projects based on a formula proportional to use of services. The formula takes into account contractor costs, trip size and length, and a percentage of operating expenses, salaries and permitting costs.

INFORMATION OFFICE

The GCMRC information office was formally established on October 9, 2003 as a result of the GCMRC reorganization. The purpose of the office is to increase awareness of GCMRC activities and products and to facilitate the dissemination of data, information, and products to the Glen Canyon Dam Adaptive Management Work Group members, Technical Work Group members, scientists, and the public. These groups of people can be collectively referred to as our constituency.

Information office objectives will be accomplished through the activities of two primary programs and four functions. The two programs are library services and systems administration. The library contains all hardcopy data, information, and products as well as digital data on electronic media. A complete catalog of library content will be maintained and searchable on the website. The library is currently undertaken a project intended to digitize all legacy hardcopy content so that it can be incorporated into and disseminated from the website. The library also coordinates the Center's peer review function. Peer review helps insure that GCMRC products are of the highest quality.

Systems administration is responsible for providing computer and network infrastructure needed for the website and library as well as the rest of the GCMRC. Systems administration also coordinates the Center's World Wide Web presence via a website on the Internet. All digital data, information, and products will be available to our constituency from this website. This plan proposes that future website development be serviced in-house to provide greater flexibility with the changing needs of the GCMRC. A new full-time Web development term position will be created that will be funded jointly by the GCMRC and the SBSC.

The library is staffed by one permanent full-time federal employee and one contract student employee. The student employee is primarily responsible for digitizing legacy hardcopy content. Systems administration will be staffed by a permanent full-time systems administrator and a full-time computer technician and Web developer shared and funded jointly by the GCMRC and SBSC.

Program implementation, primarily in the area of web development, is expected to commence in FY2004 and continue through FY2006 at which point the program will enter into a maintenance mode that will primarily involve minor system modification and the integration of new data and information as it becomes available. It is anticipated that new development cycles will need to commence on 1 to 3 year intervals depending upon the changing needs of GCMRC science activities, user needs, and advances in technology.

Functions, Programs, and Organization

The Information Office provides four functions:

1) Library services
2) Website services
3) Peer review
4) Systems administration

These functions are provided through two Information Office programs: the library and systems administration. Peer review functions are contained within the library and website functions are contained within systems administration. These functions combine to provide easy access to high quality products in an automated fashion. With the exception of the website, operating procedures for these programs and functions have been developed and implemented and the programs are fully functional. The website is currently undergoing an extensive overhaul based upon recommendations of an ad-hoc committee composed of GCMRC, AMWG, and TWG members.

Library services

The library contains the historic record of information gathered on the CRE and provides access to this information to our constituency. This is made possible through the establishment of a strict information routing protocol within GCMRC and a computerized library catalog. The information routing protocol ensures that information delivered to GCMRC is received by the library for inclusion into its collection.

The library catalog provides a comprehensive catalog of individual library content and where they are located. Library content consists of books, reports, and journal article reprints resulting from monitoring and research activities in the CRE and elsewhere; aerial and oblique photography and imagery; videotapes containing videography (aerial video) and video of programs related to the CRE; and maps. Most of this information is in hardcopy form and is only available by visiting or contacting the library. However, more and more information is being made available in digital form. The library catalog and some digital content are available from the GCMRC website.

The library facilitates monitoring and research by providing a centralized repository for hard copy information such as books, reports, maps, photography, and videos. The singularity of many library holdings require a special policy concerning the borrowing of these materials. If

any item is requested for which only one is available, it is prioritized to be converted to digital format and the digital copy is provided to the requester.

It is estimated that the library currently contains over 8000 reports, 28,000 aerial photographs and images, 8000 photographs, 700 videos, and 300 maps. Approximately 10 percent of this content is available digitally. Digital information has numerous advantages over hardcopy data including computer analysis and distribution over the World Wide Web. Because of this, GCMRC data standards require that information delivered as part of its contracts and cooperative agreements be received in digital form. The library has also embarked upon an aggressive project to digitize legacy hardcopy content over the next 5 years.

The library is staffed by one full-time Technical Information Specialist and one student contractor. The student employee is primarily responsible for digitizing legacy hardcopy content.

Website services

Aside from direct personal contact through formal and informal meetings with staff, the GCMRC website is the most comprehensive and visible interface with our constituency. The website is intended to provide multiple types of information at varying degrees of complexity to accommodate the broad spectrum of individuals who make up our constituency. These primarily are:

1) General information about GCMRC's mission and projects
2) Contact information for staff
3) Links to other relevant U.S. Geological Survey offices and GCDAMP partners
4) Fact sheets, strategic and annual work plans
5) Location map
6) Calendar of meetings and events
7) Employment opportunities
8) Notices of requests for proposals (RFPs)
9) Protocol evaluation panel reports
10) Information on large science initiatives
11) Searchable library catalog
12) Access to digital content

In addition, the website hosts electronic discussion forums for GCMRC, AMP, and the U.S. Geological Survey LiDAR discussion group and provides a number of interactive maps of the ecosystem. Related to the website is the GCMRC's FTP site that contains over 500 Gbytes of additional miscellaneous data and information. However, this information is often non-descript (data with little explanation) and difficult to navigate. It is the intent of the Information Office to

integrate this data into the GCMRC website with complete data descriptions and navigation tools. Data from other sources will be integrated into the GCMRC website as it becomes available. When fully developed, the website will be a one-stop-shop for all of your information needs related to the CRE including data and library content.

Services would include restructuring the website for improved navigation and appeal, integration of additional data including the content of the FTP site, new and improved feature content about GCMRC programs and projects suited for the public at large, and the addition of a public outreach section.

Peer review

The GCMRC has developed and implemented a rigorous peer review process to help insure the quality of products produced by its staff, cooperators, and contractors. The peer review process is coordinated by the library and addresses the review process for reports, unsolicited proposals and the annual requests for proposals. The review process is documented in the GCMRC review policy available on the website. The review process will be augmented by the forthcoming SBSC review policy.

The library maintains a database of potential reviewers organized by subject area. When a review is needed, two or three candidates are provided by the COTR and augmented by names of potential reviews selected from the database. If the database does not include enough potential reviewers, additional candidates are identified through a search of academic and journal websites. The database is dynamic in that new reviewers are sought out and added as needed while others resign their services.

Systems administration

The GCMRC computing environment is a complex system of servers, workstations, laptops, printers, plotters, disk arrays, routers, hubs, switches, tape backups, copy and Fax machines, and audio-visual and telecommunications equipment. In addition, over 50 software applications are utilized by scientists and support personnel in carrying out the collective mission of the GCMRC. The computing environment currently includes workstations, laptops, network printers, tape backup systems, and over 7 Terabytes of disk storage. These devices must work together in a reliable, seamless, and secure manner in order to facilitate the mission of GCMRC.

The systems administration program (SAP) supports the collective mission of GCMRC by providing a secure and standardized computing environment for scientists, managers, administrators, and support staff. Computer hardware is largely a combination of state-of-the-art PC (Intel) processors running the Microsoft Windows operating system. Each workstation has a core suite of software applications that include mainstream off-the-shelf integrated office products such as a word processor, spreadsheet, graphics, database, Internet browser, etc. Additional software needed for specialized scientific data processing is also available. To the extent possible, hardware and software is standardized throughout the GCMRC. Standardization facilitates the inter-office exchange of information and reduces the administrative effort needed for hardware and software support to a sustainable level.

The SAP normally replaces desktop computers, servers, and other hardware every three years on a rotational basis; however, in some cases it may be as often as every year. The newest and fastest computers first go to the areas within GCMRC that place the most demands on them. These areas have traditionally been GIS, survey, graphics users, and biostatistical users.

The SAP is staffed by one permanent full-time federal employee and one contract student employee primarily responsible for assisting with troubleshooting the GCMRC's computing environment.

SAP activities are as follows:

Desktop and servers - GCMRC's computing environment is based upon the PC platform, Microsoft Windows operating system and Microsoft Office, office automation software. The desktops consist of Micron and Dell computers (Dell has been awarded a mandatory contract by the DOI) and processors run from P3 600 megahertz to P4 3.0 gigahertz central processing units with 512 to 2gigabytes of memory. The majority of desktops are standard off the shelf configuration for cost savings. Laptops range from P2 Panasonic rugged field laptops for work in the canyon to P3 traveling laptops from Sony and Compaq for meetings and conferences. The tablet PCs are Fujitsu and primarily used for work in the field. Handhelds are Compaq IPAQ's and used primarily for field work.

GCMRC has a life cycle replacement program established. This program insures equipment will meet the research needs of GCMRC and thus the Adaptive Management Program. Hardware contract for the primary database system lowers parts replacement cost.

Systems maintenance is performed in house to facilitate quick turnaround and minimize downtime.

GCMRC currently utilizes 12 servers from P3-600 to Dual P4-400 processors and 512mb to 2gb of memory. All servers are windows based operating systems. The server environment is currently being upgraded from NT4 to Windows 2003 Active Directory. All DOI departments must move to Active Directory by Dec 2004.

Servers are utilized in the following capacity:

Primary Function	**Secondary Function**
Primary Domain Controller	File Server
GIS Server	File Server
Tape Backup Server	
Internet Web Server	FTP Server (Outside Firewall, Public)
Intranet Server	
Database Production Server	File Server
Database Development Server	File Server
Application Server	Print Server
IMS Server	
WWW Development server	Program Development Server
Active Directory Server	(will replace 2 Domain Controllers)
Database Public Server	(Outside Firewall, Public)

Network - GCMRC computer interconnectivity is provided using TCP/IP network communication protocol running on a 1000baseT and 100baseT network media. This media consists of Fiber Optic cabling between buildings and Cat5e/Cat6 internal to the buildings down to the desktop. Patch cables are purchased or built to Cat5e standards to insure compatibility with 1000baseT throughput. Network traffic is arbitrated by 5 3COM switches and hubs operating at 100 Mbps and 1 Gigabit (Gbps).

Hubs and switches are interconnected by fiber or 1 Gbps cable. All are monitored for throughput and port capacity/failure. The connections to all servers are 1 Gbps and all servers run on the same switch. This facilitates network backup and file transfer. GIS and Survey connections are 1 Gbps, or are 100 Mbps and scheduled for upgrade to 1 Gbps. This facilitates the massive amount of data processed. The majority of desktops connections are 100 Mbps. This

is our basic network connectivity for smaller file transfers, email and day-to-day processing. There are still a few 10 Mbps connections that are planned for upgrade. Connections are in a building scheduled for renovation. As switches and hubs are replaced due to equipment failure, the entire backbone will move to 1Gbps connectivity.

Internet – The SAP provides for Internet connectivity for GCMRC staff through the Flagstaff Field Center GEOnet-3 router. The router provides a secure DS-3 (45 Mbps) virtual circuit to Menlo Park where it joins the U.S. Geological Survey's GEOnet network and portal to the Internet.

Security – Computer security consumes more and more of the available SAP resources with each year in terms of budget and manpower. Vulnerabilities allowing remote access by unauthorized individuals are discovered almost daily. In addition, computer viruses are released on the Internet at large just as frequently. During the last year alone there have been over 7000 attempted hacks on GCMRC computer systems. Largely due to the diligence of the SAP in maintaining a secure computing environment, none of these hacks have been successful.

Computer security begins with a firewall located at the U.S. Geological Survey's portal to the Internet via the GEOnet network at Menlo Park. Secondly and more specifically a dual firewall exists at the Flagstaff Field Center campus. The first firewall restricts enterprise level intrusion attempts while allowing the public access to our publicly available web, database and FTP servers. The second firewall restricts external access to our internal network.

To maintain the integrity of our desktop computing environment, we employ three software programs. Microsoft Systems Update Server (SUS), Microsoft Systems Management Server (SMS) and Symantec Anti-Virus Corporate Edition (AV-CE). Microsoft Operating systems (OS) are updated to minimize vulnerabilities using SUS. SUS automates a central delivery system for patch management. This system downloads nightly all OS fixes released by the manufacture. This is then reviewed by the systems administration staff. Applicable patches are flagged for release and pushed to GCMRC computers. Computers are scheduled to retrieve updates from the SUS server each night.

All other application products, including the office suite are patched for vulnerabilities using SMS. SMS works similarly to SUS with one major exception, patches must be downloaded and a package built to be delivered to the desktops. SMS delivers the package to the desktops on an as required basis.

AV-CE virus updates are downloaded from the web to the AV-CE server as released and pushed to all systems the same night. The AC-CE server allows for central management of anti-virus information and tracking of virus infections that are introduced. Centrally managing the anti-virus software and updates insures protection is enabled on the desktops and standards are followed for scanning introduced files.

Intranet - GCMRC's intranet offers a secure centralized medium for information exchange among GCMRC employees. The intranet is located inside a firewall and is served from a Windows 2003 Server utilizing active server pages and .NET. The content is designed and maintained using the Macromedia Studio software suite and Visual Studio.net. Content is checked for compliance with USGS, DOI and federal standards. Access to the intranet from locations outside of the Flagstaff Field Center is through a virtual private network connection that provides a secure computing environment remotely.

Among things to be internally shared via the intranet are: standard operating procedures, personnel availability, internal contact info, vehicle checkout, equipment loans, internal calendar, discussion forums, interactive questionnaires, standard forms and an IT support system. This functionality is new and expected to grow with time and utilization.

System back-up and disaster recovery - Servers at the GCMRC are configured with Redundant Array of Independent (and inexpensive) Drives (RAID). GCMRC utilizes RAID 5 hot-swap disk arrays whenever possible. This allows the RAID 5 system to stay up and running before, during, and after a drive failure. RAID 5 systems store parity (redundancy) data across all hard drives equally and do not need to be powered down to change out a faulty disk drive. If a RAID 5 disk were to fail, the surviving drives have the information needed to reconstruct the data onto the replacement drive. In a RAID 5, three or more drives are used to create that configuration. The RAID 5 configuration provides excellent levels of redundancy and performance.

When raid-5 is not possible we utilize disk mirroring. This allows for a redundant copy of the data and is utilized where 3 or more drives are not present.

Network backup is accomplished using an Overland NEO series tape library. This tape library has dual Linear Tape-Open -1 (LTO-1) drives in a 30 slot carriage, capacity of 3 terabytes non-compressed, with a maximum of 6 terabytes compressed without changing tapes. Daily

backups start in the evening Monday thru Thursday, weekly and monthly backups start on Friday evening

Web and FTP Services - The GCMRC web site and FTP site serve to make the mission and findings of GCMRC accessible to the public. During the last year the GCMRC website has been accessed over 1.5 million times. This illustrates the importance of the website as a highly visible interface to our constituency.

The web server is located inside a firewall. The firewall restricts enterprise level intrusion attempts while allowing the public access to our publicly available web and FTP servers. GCMRC hosts and maintains the web and FTP sites on a Microsoft Windows 2000 Server with Internet Information Services. The web content is served utilizing Active Server Pages (ASP) and .NET. The content is designed and maintained using the Macromedia Studio software suite and Visual Studio.net. Content is checked for compliance with USGS, DOI and federal standards.

The sites offer our updated work plan, descriptions of our program areas, and various interactive stores of data including our Internet Map Server, our online library and discussion forums for GCMRC, AMP, and USGS LiDAR discussion group.

Currently we are working with the information providers to incorporate information from the FTP site (over 500 GB) into the web site. The goal in doing this is to provide the information in a user friendly format that is easier to locate.

The continuing duties involved in maintaining the web and FTP servers include: adding new content and updating existing content, ensuring that hardware and software is secure and up to date, and maintaining section 508 compliance. The web site serves a range of content, both static pages as .html (Hyper Text Markup Language) and dynamic pages by means of ASP.NET and PHP Hypertext Preprocessor (PHP). PHP is a widely-used general-purpose scripting language that is especially suited for Web development and can be embedded into HTML.)

This site is continually monitored for intrusion attempts, security updates and adjustments are applied as necessary.

Troubleshooting and maintenance - Helpdesk support is provided as requested/required. Requests are received via the web, email and telephone. Currently we utilize a program, accessible help desk, to track helpdesk request and problems in a searchable database with solutions to facilitate prioritization and resolution. This program is available

through the GCMRC website and we actively encourage all GCMRC staff to utilize this forum as a means for problem identification.

The system administration staff utilizes Systems Management Server (SMS) software to acquire remote control over user's desktops to view and / or resolve problems remotely. Hardware inventory, software inventory and licensing are also maintained through SMS. This is utilized to insure compliance with licensing limitations, DOI guidance and federal law.

Data storage - The GCMRC utilizes over 7 Terebytes (Tbytes) of on-line disk storage. This disk storage is provided by multiple servers with Small Computer System Interface (SCSI) disk arrays. Servers at the GCMRC are configured with Redundant Array of Inexpensive (or Independent) Drives (RAID). GCMRC utilizes RAID 5 hot-swap disk arrays whenever possible. Server disk arrays are configured to be hot swappable with raid 5 to minimize downtime.

Primary and secondary power supplies for each array are wired to separate Uninterruptible Power Supplies (UPS's) to provide redundancy and extend uptime during a power failure. This enables systems administration to perform a safe shut down in the event of a power outage. If this was not in place, data would be corrupted or lost during power fluctuations and outages due to server crashes.

GCMRC also utilizes Networked Attached Storage (NAS) devices. These devices are Integrated Drive Electronics (IDE) drives connected to a SCSI backplane. NAS units are used to provide bulk storage capacity at less expense than standard SCSI arrays. These drive arrays contain the repository of all digital and electronic data from GCMRC.

MANAGEMENT OBJECTIVES AND INFORMATION NEEDS

Introduction

Management objectives (MOs) and information needs (INs) help to define measurable standards of desired future resource conditions to be achieved by the AMP. The MOs and INs also drive the strategic planning process and they provide the basis for the annual monitoring and research program described in this plan.

Historical Development of the Management Objectives and Information Needs

Using the nine resource areas in the EIS, meetings and workshops were held in 1996 to formulate management objectives and to define information needs associated with the various

management objectives. These were intended to guide the development of GCMRC monitoring and research activities. In 1997 and 1998, additional discussions were held to revise Management Objectives and prioritize Information Needs. In FY 2001, the AMWG adopted a new set of MOs that resulted from its effort to develop an AMP strategic plan. The full AMP strategic plan was completed in FY 2002-03.

Revision Process

As part of the AMP strategic planning process, the INs were revised and approved by the AMWG in August 2003. The approval MOs and INs are listed in Appendix One.

The monitoring and research activities proposed in the FY 2006 Work Plan are intended to address the current management objectives and information needs. The specific MOs addressed by the monitoring and research activities proposed in this plan are listed in Appendix Two and referenced in the project descriptions.

PROTOCOL EVALUATION PROGRAM

The Protocol Evaluation Program (PEP) was initiated in 1997 to provide independent external review of all GCMRC monitoring and research programs and provide recommendations to GCMRC regarding the specific monitoring protocols that will be used. Phase I of the PEP process for evaluating current and new alternative protocols in all program resource areas, except socio-economic and recreation, was completed by the end of FY 2003. A PEP was conducted during winter 2002 for assessment of survey support services to GCMRC. The recommendations resulting from these workshops have been distributed to the TWG and AMWG and are being used to develop a monitoring plan for the Colorado River ecosystem and modify the FY 2006 work plans as appropriate. All PEP workshops and evaluations are conducted in cooperation with external experts identified through a competitive, nationwide selection process, as well as in collaboration with GCMRC science cooperators, contractors, and Technical Work Group members. All PEP final and draft reports are available through the GCMRC's web site. Phase II PEP reviews are proposed in FY 2006 for remote-sensing and physical-resource monitoring toward implementation of the GCMRC's monitoring plan.

CONTINGENCY PLANNING

The GCDAMP has adopted hydrologic criteria and resource criteria for triggering releases above peak power plant discharge from Glen Canyon Dam. When triggered, these criteria provide little lead time for monitoring and research planning. In addition, hydrologic conditions can lead to unplanned release events which may also require GCMRC to implement monitoring and research activities with little to no lead time. The possibility for unanticipated hydrologic events to force experimental treatments results in the need for contingency planning. Annually, GCMRC develops contingency plans for implementation of:

1. Effects monitoring before and (or) after unplanned events, as appropriate;
2. research assessments of above peak power plant discharges from GCD (as per the GCDEIS) or other short-duration high flow unplanned events; and
3. an effects monitoring and research program for planned events between January-July of a given year.

SCIENCE SYMPOSIUM

The GCMRC has initiated a program of regular scientific symposia to discuss the current state of scientific knowledge regarding the Colorado River ecosystem, as well as to learn about similar research in other systems. The GCMRC convenes a biennial Colorado River ecosystem science symposium, and between these years GCMRC program managers and participating scientists make presentations at the biennial Colorado Plateau symposium hosted by the Colorado Plateau Field Station of the Biological Resources Division of the USGS. The initial science symposium was convened in Flagstaff in Spring 1997, and focused on results of the 1996 controlled flood experiment. A second symposium, convened at Grand Canyon National Park in 1999, focused on monitoring and research related to the 1996 Record-of-Decision operations at Glen Canyon Dam. GCMRC hosted a third symposium in Spring 2001 that focused on the preliminary results of the Low-Steady Summer Flows implemented during Summer 2000. A fourth science symposium was held in Tucson in Fall 2003. The GCMRC will host its fifth science symposium in October, 2005, to present preliminary results from the FY 2003-05 experimental treatments, as well as report on the current status of knowledge about the initial phase of its long-term monitoring program.

CHALLENGES

GCMRC and the adaptive management program, in general, face a number of challenges with respect to designing monitoring and research activities to gather information on specific experimental management actions. These include potentially both the construction and operation of a temperature control device (TCD) on Glen Canyon Dam and the implementation of experimental endangered fish flows to satisfy the 1995 biological opinion on the operation of Glen Canyon Dam.

SCHEDULE AND BUDGET

In the FY2006 budget proposal for GCMRC, the costs are not necessarily correct for FY 2005. This is because of a discrepancy in funding amounts and application of the USGS $1 million appropriation discovered by GCMRC and the BOR during a January, 2005 budget meeting held in Salt Lake City. The expenses identified will need to be reworked to account for the discrepancy in funding and cost share expenses as well as the 15% DOI customer burden.

The total FY 2005 and FY 2006 budgets for the AMP are $10,664,600 (uncorrected) and $9,891,315, respectively. These totals include $8,672,600 in FY 2005 and $8,889,415 in FY 2006 from AMP Power Revenues; and $210,000 and $215,250, respectively, from the Bureau of Reclamation Water Quality fund for both years.

For information about other AMP activities and budget, and the Programmatic Agreement, please contact Mr. Dennis Kubly at the Bureau of Reclamation, Salt Lake City, Utah.

Budget Review

Should the appropriated funds requested to support the GCMRC FY 2006 Work Plan not be fully funded, GCMRC will work with the AMWG to try and secure the required funds using all available budget mechanisms. Second, GCMRC will review the FY 2006 budget and identify specific work activities that could be deferred. The list of activities that could be potentially deferred will be discussed with the TWG and AMWG. A recommendation supporting GCMRC's proposed prioritization and deferral of specific work activities in FY 2006 will be sought from the AMWG.

CHAPTER 2

SCIENCE ACTIVITIES

A. PHYSICAL SCIENCE, MODELING AND DASA PROGRAM

Project A.1. *Monitoring* - IQWP – Upstream Monitoring of Lake Powell Water Quality - Funding from Bureau of Reclamation O&M

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor	94,000	25,000	25,000	29,000	0
Logistics Field Support	0	0	0	0	0
Project Related Travel/Training					10,000
Operations/Supplies	25,000	25,000	25,000	35,000	38,924
GCMRC Salaries	146,000	151,000	128,000	115,000	138,250
Project Subtotal	—	—	—	—	187,174
USGS Assessment (15%)	0	36,000	32,000	31,000	28,076
Funding to GCMRC	265,000	237,000	210,000	210,000	215,250
Reclamation Assistance	35,000	114,000	*0	*0	?
Project Total	300,000	351,000	210,000	210,000	215,250
% Total Outsourced	35%	10%	~12%	~14%	0

Principal Investigators: Vernieu (Lake Powell Coordinator) and Hueftle, U.S. Geological Survey (GCMRC)

Statement of Problem: Water quality refers to the physical, chemical and biological characteristics of water. The components affect higher-level community composition, quality and interactions and represent a cornerstone resource upon which all other downstream aquatic and terrestrial resources depend. The water quality parameters are linked to upper basin inflows, reservoir dynamics, and operations of Glen Canyon Dam, and downstream tributary inputs. The relationship between operations of Glen Canyon Dam and water quality variables affecting downstream resources is a management concern. Of special concern is the current draw-down condition in Lake Powell, resulting from several years of drought. Total capacity has been reduced 40%, resulting in warm releases, deltaic sediment resuspension, dissolved oxygen reductions and salinity increases.

Summary Project Description: Funded by an interagency agreement with the Bureau of Reclamation Upper Colorado Regional Office, GCMRC conducts monitoring and research on Lake Powell to meet the following information needs.

- Determine status and trends of physical, chemical, and biological components of water quality in the Lake Powell reservoir as a function of regional hydrologic conditions and their relation to downstream releases. These components include temperature, specific conductance, dissolved oxygen, pH, turbidity, major ions, nutrients, trace elements, chlorophyll, plankton, and organic matter.
- Determine stratification, convective mixing patterns, and behavior of advective currents in Lake Powell and their relation to Glen Canyon Dam operations to predict seasonal patterns and trends in downstream releases.
- Determine status and trends of physical, chemical, and biological components of water quality in Glen Canyon Dam releases.
- Evaluate quality and collection methods of existing data and determine where monitoring activities should be implemented, augmented, revised, decreased, or discontinued.

Decreased funding in the project reflects a combination of personnel restructuring, reduced chemical sample collection and processing, direct funding from USBR for sample analysis and field assistance and redirection of effort in development of the downstream water quality program. USBR supplies support personnel and funding for technical field assistance and maintains service contracts for chemical sample analysis, further reducing the amount of direct funding to GCMRC.

MO's and IN's ADDRESSED: Goal 7, MO's 7.1, 7.2, 7.3; CMIN 7.3.1.

Status/Schedule: Monthly and quarterly monitoring program for Lake Powell. Sampling for major ions and nutrients, temperature, conductivity and dissolved oxygen, and other basic parameters. Reservoir drawdown from current drought has resulted in increased release temperatures, resuspension of deltaic sediments, and the potential for hypoxic releases in 2005. Since 2005, chemical analysis is being provided by the USBR Lower Colorado Regional Laboratory through a service agreement with the UC Region. Beginning in 2004, monthly web-based updates of water quality status have been provided on the GCMRC web site. Data from this project provides a basis for predictive capability for downstream water quality parameters, including temperature.

Expected Products/Deliverables:

- Monthly web site report
- Annual water year open file report
- Complete Lake Powell water quality database
- Publish and provide on-line access to historical water quality information
- Contribution to SCORE report

Integration: During FY 2006, new research on food web dynamics will be initiated through a competitive process. As this effort gets underway, the Integrated Quality of Water program will be evaluated and modified to meet the needs of this new research effort, as well as other existing project. The Lake Powell monitoring program will be included in these evaluations, as well as any planning that occurs related to future implementation of thermal modification experiments.

Project A.2. – *Monitoring*, IQWP – Downstream Monitoring of Suspended-Sediment Transport and Quality-of Water for Physical, Biological and Chemical Sampling

FUNDING HISTORY*	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor	329,000	476,000	614,500	927,500	500,000
Logistics Field Support & MPS	40,000	40,000	152,000	160,000	90,000
Project Related Travel/Training	—	—	—	—	15,000
Operations/Supplies	235,500	130,500	142,500	190,000	70,000
GCMRC Salaries	81,000	162,000	195,000	330,000	293,150
Project Subtotal	—	—	—	—	968,150
DOI Customer Burden (15%)	—	—	—	—	145,223
Project Total	685,500	808,500	1,104,000**	1,607,500**	1,113,373
% Total Outsourced	~51%	~61%	~63%	~63%	~52%

* In earlier annual plans and budgets, this project was previously described and budgeted as two separate projects, one relating to Downstream Quality of Water monitoring and the other relating to the monitoring of suspended-sediment flux. The FY 2002-2005, budget totals shown here reflect the combined sums of costs from the two projects, respectively, shown in the previous work plans. Combining the two projects is done to better integrate the monitoring and the FY 2006 efforts combine the logistical support needed for accomplishing the suspended-sediment mass flux with other downstream quality-of-water monitoring.

** The FY 2004 & 2005 total project costs reflect additional research funding to support additional monitoring of the experimental Fluctuating Flows in 2003-2004, & the High-Flow test conducted in November 2004.

Principal Investigators: Topping, Wright, Melis, Rubin and Wiele, U.S. Geological Survey National Research Program, GCMRC, Marine Geology Team and Arizona District of Water Resources Discipline, respectively.

Statement of Problem: Glen Canyon Dam has altered the character of the water that is released downstream into the Colorado River. The supply of fine sediment has been reduced to nearly zero, which has impacted fine sediment deposits and turbidity in Glen, Marble, and Grand Canyons. The thermal regime of the releases has changed from seasonal variations that followed air temperatures to nearly constant release temperatures throughout the year which are colder in the summer and warmer in the winter than pre-dam temperatures. These changes, as well as changes in the downstream delivery of minerals, nutrients, and carbon have altered the ecosystem of the Colorado River downstream from Glen Canyon Dam. The Lake Powell Project characterizes the water quality of the lake and downstream releases. This project monitors how the releases affect the downstream ecosystem and develops tools to assist decision-makers in the management of Glen Canyon Dam.

Summary Project Description:

The downstream IQWP has two major components. The first component is focused on monitoring and modeling the mass-balance of fine sediment in the CRE. The second component of IQWP is focused on characterizing other water quality components of the ecosystem, such as water temperature, oxygen, nutrients, and carbon. Each component has monitoring and research elements as described below.

Downstream Monitoring Components:

1. **Fine sediment mass balance**: Use of laser-acoustic system and conventional suspended-sediment samples to monitor transport at several locations along the mainstem Colorado River and on key tributaries. Monitoring data are used to provide a continuous accounting of the mass-balance (input minus export) of sand and fine sediment in Marble and Grand Canyons and to assess the impacts of experimental flows on the mass-balance.

2. **Continuous water quality monitoring:** Temperature, conductivity, dissolved oxygen, and pH are monitored at several locations along the mainstem Colorado River and key tributaries. Most sites are coincident with the mass-balance monitoring locations. Temperature monitoring in selected backwater habitat areas. Data are used to characterize the thermal regime and longitudinal gradient in mineral and oxygen content of the river, and to calibrate and validate numerical models.

Research Components:

1. **Numerical model development and application**: Fine sediment transport models are currently in use and under development. Research includes flume studies and detailed flow measurements of sediment transport dynamics. Water temperature model development is underway. Research includes detailed measurements of heat exchange between the river and the atmosphere; water temperature dynamics in backwater habitat areas.
2. **Real-time two-way telemetry**: A system is being developed to provide two-way telemetry between the office and instrumentation in the Canyon. The two-way communication not only provides real-time access to data, but also allows the user full control of the instrument from the office. The system is being developed in a generic fashion to allow use with any instrument that uses serial communications.
3. **In-stream Metabolism experiments**: Previously collected single-station and two-station dissolved oxygen data is currently being evaluated and used for metabolism calculations. Further research may include additional dissolved oxygen data collection at various sites.
4. **Nutrient- Carbon budgeting**: Future research directions may include the development of nutrient and carbon budgets for the CRE.

MO's and IN's ADDRESSED: Goals 7 and 8; MO's 7.1, 7.2, 7.3, 7.4, and 8.1; CMIN's 7.1.1, 7.2.1, 7.3.1, 7.4.1, 7.4.2, 8.1.2, 8.1.3.

Status/Schedule: FY02-06: Monitoring activities are ongoing and scheduled to continue. Analysis of the November 2004 high-flow test data is scheduled to continue into FY06. Completion of the initial phase of suspended-sediment transport model development is scheduled to be completed in FY05 with continued refinement in FY06. Water quality model development to continue with scheduled completion of the water temperature component in FY06.

Expected Products/Deliverables:

- Preliminary real-time data posted to World-Wide-Web for some sites for parameters that do not require extensive processing.
- Preliminary data made available in real-time through the GCMRC Oracle database using the in-development two-way telemetry system.
- Final, reviewed data made available through GCMRC Oracle database annually.
- Annual Open-File Reports summarizing methods and collected data.
- Peer-reviewed publications where appropriate, including assessment of the November 2004 high-flow test.
- Presentations at AMWG/TWG meetings as well as other professional meetings.
- Numerical models made available for general use at appropriate time.

Integration: The fine sediment mass balance project is intimately linked with the fine sediment storage project because the mass balance should track with changes in storage. The water quality project will become integrated with the new aquatic foodbase program as it develops.

Project A.3. Finalize 2001-2005 *Monitoring& Research* – Changes in Fine-Sediment Storage along the Main Channel & Shorelines of the CRE

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor	300,000	300,000	621,000	760,000	256,250
Logistics Field Support	58,000	18,000	120,000	120,000	0
Project Related Travel/Training	—	—	—	—	0
Operations/Supplies	100,000	93,000	63,000	60,000	0
GCMRC Salaries	53,000	31,000	56,000	60,000	0
Project Subtotal	—	—	—	—	256,250
DOI Customer Burden (15%)	—	—	—	—	38,438
Project Total	511,000	442,000	860,000*	1,000,000*	294,688
% Total Outsourced	~68%	~71%	~79%	~87%	100%

*The FY 2004 & 2005 project totals include extra data acquisition costs for monitoring effects of experimental Fluctuating Flow & the sediment High-Flow test implemented in November 2004. The FY 2006 costs are to support final reporting on the 2001-2005, monitoring and research related to the High-Flow test.

Principal Investigators: Rubin, Topping, Schmidt and Parnell, U.S. Geological Survey (WRD, GD & BRD, plus Utah State and Northern Arizona Universities)

Statement of Problem: Sandbars and other sandy deposits in and along the Colorado River in Grand Canyon National Park (GCNP) were an integral part of the pre-dam riverscape, and are important for habitat, protecting archeological sites, and recreation. These deposits have eroded substantially following the 1963 closure of Glen Canyon Dam that reduced the supply of sand at the upstream boundary of GCNP by about 94%; sandbars in Marble Canyon have decreased in size by about 25% during the last 15 years. Results from the geomorphic synthesis project have shown that the deeper portions of eddies and the channel pools also contain about 25% less sand, silt, and clay than they contained in the early 1990s.

Relationships between Glen Canyon Dam operations, fine-sediments input from gaged and ungaged tributaries below the dam, and interrelated downstream biological, socio-cultural resources are of primary management concern. This is true owing to the fact that sand bars are the primary substrate along many shoreline areas of the ecosystem. Monitoring data on fine-grained (sand and finer) deposits, linkages with physical habitats and relationships to non-physical resources and processes offer insight on the effectiveness of the Secretary's 1996 Record-of-Decision (ROD), relative to management objectives.

Annual-to-biennial monitoring of fine-grained sediment storage provides information: (1) on the status of near-shore aquatic and terrestrial habitats where vegetation and associated fauna, socio-cultural resources are of management concern; (2) on the availability of fine-grained sediment that can be periodically manipulated through controlled floods to preserve and sustain downstream resources dependent on fine sediment; (3) on identification and interpretation of linkages between dam operations and changes in physical habitats and related ecosystem resources. All three areas of information support science-based evaluations of large-scale flow experiments (e.g., the Secretary's actions), and associated decision responses required for adaptive management to succeed.

Summary Project Description: Fine-grained deposits (sand and finer) of the main channel constitute a major storage component of the Colorado River ecosystem's sediment budget. Glen Canyon Dam operations influence fine deposits in ways that affect aquatic and terrestrial habitats over both short and long periods. The emphasis of this long-term monitoring project is to document system-wide changes in fine-grained deposits relative to dam operations and natural inputs, with emphasis on key storage settings within critical reaches. This project was initiated through release of a competitive solicitation in October 2000. The first phase of this project was scheduled for completion at the end of FY 2005 but has been extended through FY 2006 owing to the additional field data collection campaign around the November high-flow test, and will be externally reviewed through the PEP process. In addition, the project is also focused on researching the fate of campsite areas on an annual basis, as well as the fate of sand bars reworked by wind in the vicinity of archeological preservation sites.

Two other subcomponents of this project include monitoring sediment deposition in arroyos near archaeological sites and monitoring changes at campable beach areas owing to

experimental high flows. These projects are described in the *Two-Year Science Plan for Experimental Flow Treatments and Mechanical Removal Activities in WY'S 2002-2004*.

MO's and IN's ADDRESSED: Goal 8, MO's 8.1, 8.2. 8.3, 8.4, and 8.5; CMIN's 8.1.1, 8.2.1, 8.3.1, 8.4.1, 8.5.1.

Status/Schedule: FY01-06: This project was scheduled for completion in FY05 but will be extended into FY06 because of the additional field work around the November 2004 high-flow test. No additional field work is scheduled, and FY06 will serve as the reporting year for this project.

Reports published to date:

- Rubin, D.M., in press, A simple autocorrelation algorithm for determining grain size from digital images of sediment: *Sedimentology*.
- NAU Fact Sheets.
- Hazel, J.E., Jr., Topping, D.J., Schmidt, J.C., Kaplinski, M., and Melis, T.S., Downstream effects of a dam on sediment storage in a bedrock canyon: the relative roles of eddy and channel storage for the Colorado River in Marble Canyon, AZ, in press.

Expected Products/Deliverables:

- Final report summarizing the findings of the FIST project, including an assessment of sandbar changes between 2000 and 2005 and the effects of the November 2004 high-flow test.
- 2-3 more peer-reviewed journal articles or USGS reports during FY 2006.
- All reach data from this project delivered to the GCMRC database coordinator during FY2006 as scheduled under the original project timeline defined in FY2001.

Integration: This project is closely integrated with the Integrated Quality-of-Water Project, particularly the fine sediment mass balance.

Project A.4. Support of Monitoring Data (FY05 Airborne, Digital Imagery and Automated Photogrammetry) DASA Coordinator (T. Gushue), Remote Sensing Support (F.M. Gonzales)

FUNDING HISTORY	Fiscal year				
	2003	2004	2005	2006	2007
Outside GCMRC Science/Labor	82,500	123,000	170,000	0	56,500
Logistics Field Support	N/A	20,000	5,000	0	0
Project Related Training/Travel	0	0	0	0	15,000
Operations/Supplies	0	0	0	0	56,000
GCMRC Salaries	20,000	20,000	25,000	82,100	84,200
Project Subtotal	—	—	—	82,100	211,700
DOI Customer Burden (15%)	—	—	—	12,315	31,755
Project Total	102,500	163,000	200,000	94,415	243,455
% Total Outsourced	80%	82%	85%	0%	23%

Note: Additional funds are required starting in FY2007 to support ongoing management of the system wide airborne remotely-sensed data collected in May 2005. FY2007 budget elements shown here are merely estimates provided by the DASA staff. Examples of ongoing needs to support digital overflights include additional services and licenses required to serve these data.

Principal Investigators: DASA Coordinator (T. Gushue), U.S. Geological Survey (GCMRC)

Statement of Problem: Sediment and vegetation data are important at various scales to numerous scientists and resource managers. Past monitoring efforts have focused on expensive, large-scale, manual data collection aimed at small areas of the CRE. These were supplemented by collecting hard-copy aerial photography to help in manual interpretation. In FY2004, further development was made in automated processing of multi-spectral digital imagery to accurately map the two-dimensional distribution of fine-grained sediment deposits (sand) above 8,000 cfs on a canyon-wide basis. These products were derived from the system-wide digital overflight collected in May 2002, which offered a spatial resolution of 44 cm for the red, green and blue color bands, 22 cm for the panchromatic band, and a horizontal accuracy (RMSE) of 30 cm. Digital elevation data accompanying the imagery provided 1-meter resolution with a vertical accuracy (RMSE) of approximately 40 cm as measured against survey data. While these vertical accuracies are just outside the error range deemed acceptable to physical scientists for change detection, they are more than acceptable to resource managers that are concerned with canyon-

wide changes in sediment, vegetation and camping beaches. An FY 2005 airborne remote-sensing mission to replicate these data on a system-wide scale collection provides the necessary inputs for determine changes to the resources in the CRE between May 2002 and May 2005. Efforts in FY 2006, will focus on management of these digital data and preparation for serving both the 2002 and 2005 imagery so that change detection analyses can be accomplished in 2007 through 2008. The next system-wide overflight is proposed for FY 2009.

Summary Project Description: In accordance with the DASA program's long-term monitoring goals, an airborne mission to collect digital imagery for the entire CRE from Glen Canyon Dam down to Lake Mead was implemented in May 2005. Those data, along with the 2002 imagery fulfill the proposal currently offered by GCMRC to collect system-wide aerial imagery about every 4 years as outlined in the draft Core Monitoring Plan. The May 2005 dataset is similar to that collected in May 2002, using digital sensors mounted in a fixed-wing aircraft to collect data for both panchromatic and red, green, blue (RGB) bands in the visible spectrum as well as near-infrared data. A Digital Surface Model (DSM) with a 1-meter pixel resolution will also be a part of the dataset from this mission. The DSM will be comparable to that collected in May 2002 for change detection in the non-vegetated, open sand areas. For purpose of review, the following is provided as an approximate cost for acquisition of this imagery in 2005. Additional funds are needed to continue supporting management of the expanding imagery dataset in the Oracle data base as multiple data layers are obtained through 2009 (see 2007 budget elements shown in budget table above).

Breakdown of Costs for May 2005 System-wide Overflight

Year	Remote Sensing Component	Cost per km	Kilometers	Total Cost
	• **Digital Multi-spectral Imagery**	**$869**	**480**	**$417,000**
	• **Digital Surface Model (1-meter)**			**$172,000**
	• **Mission Overhead / Labor**			**$41,000**
	• **TOTAL PROJECT COST**			**$630,000**

MO's and IN's ADDRESSED: Goal 12; CMINs: All, or most, related to mapping changes in terrestrial ecosystem.

Consequences of FY06 Funding Recommendations: Owing to the fact that the FY 2005 budget was able to support a system-wide digital overflight in support of the Experimental High-

Flow Test for sediment, the FY 2006 budget for this project is reduced to cover only the salary of the GCMRC's remote-sensing coordinator within the DASA. This strategy allows funds to be made available to support the fourth year of experimental mechanical removal of salmonids below Lees Ferry.

Status/Schedule: The System-wide remote sensing mission is scheduled for May 2005 (with another flight proposed for 2009) with products expected to be delivered by the end of September 2005. During the first half of FY 2006, a quality and accuracy period will immediately follow the receipt of all deliverables and should take approximately one to four months, after which time existing automated procedures will be adapted for the newly acquired data and used to perform a variety of spatial analyses designed to determine changes to the resource over time. The remainder of FY 2006, the DASA staff will upgrade the various servers associated with the Oracle data base, so as to prepare for management and serving of the 2005 imagery. Some limited analyses of the imagery, relating to the November 2004 Experimental High-Flow Test, will also occur during FY 2006, within the context of final analysis and reporting by the Fine-Grained Storage research project.

Expected Products/Deliverables:

- Canyon-wide, four band, multi-spectral digital imagery at 25 cm spatial resolution.
- Canyon-wide, panchromatic digital imagery at 25 cm spatial resolution.
- Canyon-wide, digital surface model at 1 meter spatial resolution.

Integration: The system-wide imagery dataset will provide the necessary base information for all mapping and spatial analysis, and coupled with selected automated-classification techniques, the data will then be made available to the physical, biological and cultural resource programs as baseline monitoring data and information from which program assessments can be made, resource theses tested, and more detailed data collection efforts planned.

Project A.5. *Data Storage* (DASA) – Grand Canyon Integrated (Oracle) Database Management, Acting System Manager (G. Bennett)

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor	100,000	251,000	18,000	15,000	27,200
Logistics Field Support	—	—	—	—	0
Project Related Training/Travel	3,000	1,000	2,000	3,000	3,000
Operations/Supplies	10,000	10,000	5,000	5,000	12,000
GCMRC Salaries	56,000	67,000	80,000	89,000	89,000
Project Subtotal	—	—	—	—	131,200
DOI Customer Burden (15%)	—	—	—	—	19,680
Project Total	201,000	363,000	128,000	128,000	150,880
% Total Outsourced	50%	69%	~14%	~12%	~21%

Principal Investigators: DASA Coordinator (T. Gushue), U.S. Geological Survey (GCMRC)

Statement of Problem: The need for a comprehensive database for maintaining this information was recognized by the National Academy of Sciences in their initial review of the GCES Program in 1987, and reinforced during a second review in 1990. Extensive data and information currently exists in the GCMRC collections relating to resource conditions, quality, and relationships to other resources. Potentially equal amounts of data and information exist within museums, universities, agencies, etc. However, much of this information has not been organized, managed or integrated into an analysis of the interrelationship among various resources and dam operations.

Summary Project Description: The purpose of the GCMRC Database Management System (DBMS) is to store and deliver all tabular and spatial data, via our Spatial Data Engine (SDE), gathered as the result of GCMRC investigations and legacy data. Developing the DBMS requires inventorying, organizing, archiving, and developing delivery systems for many years worth of environmental data collection activities representing a vast array of disparate data including

physical, biological, cultural, socio-economic, and climatic information. Many datasets have been integrated into our DBMS with additional datasets in working progress. The additional data yet to be included in our DBMS are organized in Microsoft Excel files, Microsoft Access databases, SAS, or another proprietary format. The DBMS program is currently working on bringing together years of disparate historical data, collected by multiple entities located in databases across the southwest, in an organized fashion and then deliver it transparently to stakeholders and researchers for decision making and modeling purposes. Delivering data in an automated fashion is key to the success of the DBMS. Accommodating such a task will be done utilizing database driven web pages and ArcIMS, a web accessible tool to allow access to our spatial data. These technologies can be integrated to deliver tabular and spatial data referenced through the Oracle relational database.

MO's and IN's ADDRESSED: Besides supporting Goal 12, the DBMS indirectly assists GCMRC personnel and cooperators in completing the majority of other resource MO's and IN's.

Consequences of FY06 Funding Recommendations: The currently proposed budget for FY 2006 will allow the database development to continue, but at a very minimal level and pace. The Grand Canyon Integrated Databases is currently severely understaffed and there is a constant threat of losing the knowledge base necessary for basic database maintenance as well as the development of new procedures that will allow increased access to the database for scientists, resources managers and the public alike. Significant progress had been made in database accessibility during the second half of FY2004 and the beginning of FY2005, unfortunately, owing to a change in personnel this aspect of database development is likely to be reduced until the recently vacated role of database programmer can be filled.

Status/Schedule: FY01-03 – DBMS development produced the following datasets: Fish Monitoring Data (1977 to present); Discharge unit values (1921 to present); Lake Powell water quality (1986 to present); Sediment transport data (1921 to present); Water temperature (downstream); Survey Control database.

FY04-05 – Develop applications to interact with database, set up database outside firewall for external read-only access, conduct training sessions, manage (backup, recover, and tune), service data requests, and continue developing schemas.

Expected Products/Deliverables:

- Integrated DBMS (Internal read-write database and external read-only database)
- Applications for accessing both databases
- Documentation for backups, recoveries, DBMS daily tasks, and disaster recovery

Project A.6. *Remote Data Access & Control,* (DASA) – Geographic Information Systems: Automated Monitoring Technologies and Applications, Advanced Programmer (G. Bennett)

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor	0	8,000	0	0	12,000
Logistics Field Support	—	—	—	—	0
Project Related Travel/Training	0	0	0	0	2,000
Operations/Supplies	0	0	10,000	10,000	10,000
GCMRC Salaries	0	20,000	70,000	70,000	0
Project Subtotal	—	—	—	—	24,000
DOI Customer Burden (15%)	—	—	—	—	3,600
Project Total	0	28,000	80,000	80,000	27,600
% Total Outsourced	N/A	30%	0%	0%	50%

Principal Investigator: DASA Coordinator (T. Gushue), plus part time student contractor.

Statement of Problem: Data collection in the CRE is inherently difficult and expensive owing to the remote nature of the canyon environment. Past efforts have focused on expensive, large-scale, manual data collection efforts aimed at small areas of the CRE. Research and analysis conducted during the Remote Sensing Initiative (FY2000-2003) concluded that various remote sensing data products could be utilized for numerous monitoring activities, with a coincident increase in the area being monitored and a reduction in per unit costs. Within GCMRC, the Geographic Information Systems (GIS) program is focusing on selecting a suite of remote sensing technologies / products and developing analysis routines for automating the extraction

and classification of information customized to the monitoring needs of scientists within the physical, biological and cultural resource programs and resource managers.

Integration: Classification products will be provided to the physical, biological and cultural resource programs as baseline monitoring data and information from which program assessments can be made, resource theses tested, and more detailed data collection efforts planned.

Summary Project Description: In FY2003, GCMRC showed that automated processing of multi-spectral digital imagery could be utilized to accurately map vegetation and the two-dimensional distribution of fine-grained sediment deposits (sand) above 8,000 cfs on a canyon-wide basis. Data collected in May 2004 has recently been received and is currently being checked by the DASA team. In FY2005, the analysis techniques previously employed will be repeated with an emphasis on change detection for the two-year period (May, 2002-04) once the imagery dataset has passed an accuracy assessment and made available for analysis. Techniques will also be developed for automated processing and classification of data acquired from the terrestrial and hydrographic LiDAR missions collected in conjunction with the experimental high flow of November 2004. The datasets develop from these techniques will be compared to and integrated with existing multi-beam sonar data collected during the same time span. Additional effort will be put towards synthesizing the various LiDAR datasets from both pre- and post-flood missions, and using these data for change detection analyses associated with the high flow.

Project Goals and Objectives: Automated processing of remotely sensed data products is designed to quickly and accurately classify large sets of raster and vector data into monitoring information that are useful to scientists and resource managers.

MO's and RIN's ADDRESSED: Goal 12 and others related to specific resource monitoring and research objectives.

Consequences of FY06 Funding Recommendations: In FY06 a significant reduction in available funds has occurred compared to the prior fiscal budget. Funds previously used to GCMRC salaries FY04-FY05 have shifted to reflect a change in the organizational structure of the Center. The repeatability of automated procedures will allow for the DASA team to continue development of the anticipated products outlined in this project. With fewer resources available,

however, it is expected that the time frame in which the procedures and analyses can be tailored to the new datasets will be somewhat longer.

Expected Products:

Products derived from multi-spectral digital imagery:

- Fine-grained sediment inventory and change detection: May, 2002-4 and May, 2004-6.
- Undifferentiated vegetation inventory and change detection: May, 2002-4 and May, 2004-6.
- Camping Beach inventory and change detection: May, 2002-4 and May, 2004-6.

Products derived from very high resolution LiDAR:

- Technical report outlining methodology for automated or semi-automated classification of very high resolution LiDAR into vegetation and non-vegetation components.
- Bare-earth elevation models for selected monitoring areas in Marble Canyon: May, 2004 and May, 2006.
- Changes in sub-aerial sand bar morphology based on very high resolution LiDAR: May, 2004-06.
- Vegetation canopy volumes derived from very high resolution LiDAR: May, 2004 and May, 2006.

Products derived from hydrographic LiDAR and multi-beam sonar.

- Report summarizing the applicability of hydrographic LiDAR for monitoring sub-aqueous bathymetry and fine-grained sediment deposits in the CRE.
- Technical report outlining methodology for automated classification and estimation of eddy deposit volumes using multi-beam sonar.
- Changes in sub-aqueous eddy deposit volumes based on hydrographic LiDAR and / or multi-beam sonar.

Recommended Approach/Methods: A variety of existing methods will be customized to achieve automation in analysis of remotely sensed imagery. In addition, new applications will be developed on an "as-need" basis to meet the requirements of conducting change detection for resources of concern in the Colorado River ecosystem.

Status/Schedule: Products to be delivered in FYs 2004-07.

Experimental Component: GIS applications will be applied, as needed, to a variety of remotely sensed data sets collected in support of high-flow experiments designed to test various

sediment-conservation hypotheses. Examples include: sand volume and area change detection and channel-bed substrate classification.

Project A.7. *GIS Support* (DASA) – Geographic Information Systems: GIS General Support for Integrated Analyses and Projects, GIS Leader, (T. Gushue)

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor	8,000	8,000	0	0	50,200
Logistics Field Support	—	—	—	—	0
Project Related Travel/Training	0	0	0	0	5,000
Operations/Supplies	50,000	46,000	15,000	15,000	15,000
GCMRC Salaries	91,000	76,000	65,000	65,000	69,800
Project Subtotal	—	—	—	—	140,000
DOI Customer Burden (15%)	—	—	—	—	21,000
Project Total	149,000	130,000	80,000	80,000	161,000
% Total Outsourced	5%	6%	0%	0%	~36%

Principal Investigator: GIS & DASA Coordinator (T. Gushue), plus one GIS contractor.

Statement of Problem: The traditional role of the GIS Program is inherently service-oriented, providing spatial database development, programming and analysis support to the science programs and their cooperators on both a planned and an as-needed basis. To continue functioning in this capacity it is imperative to factor in designated blocks of time to maintain and in some cases improve the level of GIS support. There is also a need for a higher level of support for more specific GIS application development and analysis of available spatial data.

Integration: Analyses performed using GIS tools will allow for, and often require, the integration of datasets from across several scientific disciplines. An example of this would be using the existing shoreline habitat dataset, which is geomorphic in nature, in junction with terrestrial vegetation for developing a food base generation dataset.

Summary Project Description: Work performed by GIS personnel for physical, biological and cultural resource projects include but are not limited to the following: Data entry and GIS database development, analysis of new and existing spatial data, map and graphic generation for field collection, presentation and publication purposes.

Project Goals and Objectives: To provide spatial products and analysis capabilities to the physical, biological and cultural resource programs and their cooperators.

MO's and RIN's ADDRESSED: Those associated with Goal 12 and others related to specific resource monitoring and research objectives for the Colorado River ecosystem.

Consequences of FY06 Funding Recommendations: The increased level of support within funding levels are constant, and provide a level of services similar to FY04.

Expected Products: Products derived from GIS support include maps for publications, generation and printing of maps and graphics for posters, creation of improved base maps for Lake Powell and Grand Canyon, instructional sessions for staff, cooperators and contractors on GIS layer development, integration and analysis, and advanced spatial analysis for monitoring projects.

Recommended Approach / Methods: Standard GIS applications, plus customized programming developed by the DASA coordinator intended to facilitate and expedite rapid analysis of data collected by GCMRC science staff, cooperators and various contractors.

Status/Schedule: Products to be delivered in FYs 2004-05.

Experimental Component: Standard GIS and Oracle data applications will be applied, as needed, to a variety of remotely sensed data sets collected in support of high-flow experiments designed to test various sediment-conservation hypotheses. The GIS department will also assist in directing data collection protocols of scientists prior to and during key experimental treatments and will also assist in post-processing and analysis of experimental data sets.

B. BIOSCIENCES

Project B.1. ***Monitoring*** **– Terrestrial Compliance Monitoring (KAS and SWWF)***

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor	10,000	30,000	21,000	22,000	55,000
Logistics Field Support & MPS	40,000	33,000	37,000	35,000	45,000
Project Related Travel/Training	—	—	—	—	5000
Operations/Supplies	16,000	6,000	7,000	7,000	0
GCMRC Salaries	16,000	12,000	14,000	15,000	87,400
Project Subtotal	—	—	—	—	192,400
DOI Customer Burden (15%)	—	—	—	—	28,860
Project Total	82,000	81,000	79,000	79,000	221,260
% Total Outsourced	48%	69%	64%	63%	29%

Note: In FY06 there were be no other planned terrestrial data collection under the biology program due to funding limitations and in accordance with funding priority directives provided by the Adaptive Management Work Group.

Principal Investigators: Arizona Game and Fish Department, TBD, U.S. Geological Survey (B. Ralston).

Statement of Problem: Kanab ambersnail and southwestern willow flycatcher (SWWF) are federally listed endangered species that occur with the Colorado River ecosystem. Kanab ambersnail is endemic to Vaseys Paradise, though a translocated population exists at Elves Chasm. The snail and its habitat is a unique ecosystem identified as a resource of concern by stakeholders. The abundance and distribution of the snail and the quality of its habitat is influenced by operations of Glen Canyon Dam, as well as by springs located at Vaseys Paradise. Monitoring of habitat area and ambersnail numbers occurs on a more detailed scale due to the limited nature of the habitat. These surveys occur twice per year. Southwestern willow flycatchers utilize habitat in lower Marble Canyon and in western Grand Canyon. Surveys for SWWF follow standard protocols developed by USFWS that require surveys in May, June and July. Surveys assess presences of breeding pairs.

Monitoring of Kanab ambersnails and utilized habitat, and southwestern willow flycatcher breeding pairs: (1) is a compliance requirement and allows managers to assess the status of this endangered species (2) provides data on the effect of periodic management of sediment through high flows under the Record of Decision on the population dynamics and habitat interactions of Kanab ambersnail.

Summary Project Description: To determine the extent of Kanab ambersnail habitat at Vaseys Paradise and estimate the abundance of Kanab ambersnails at Vaseys Paradise. To determine the presence of breeding pairs of southwestern willow flycatchers within the CRE. Specific objectives of the project include:

- Provide habitat estimates and change detection of habitat of Kanab ambersnail for varying stage levels.
- Provide yearly estimates of adult snails at Vaseys Paradise
- Provide data to use in population model development for snails at Vaseys Paradise.
- Identify the location of breeding pairs of southwestern willow flycatchers.

MO's and IN's ADDRESSED: Goal 5 and 6, MO's 5.1, 5.2, 6.6, 6.7; CMINs 5.1.1, 5.2.1, 6.7.1.

Status/Schedule: FY01-05 – Initiated in its current design as a monitoring effort in FY 2001 through a cooperative agreement with AGFD. FY2005 should initiate review of methodologies and incorporation of methods that utilize less intrusive methods to estimate KAS numbers.

Expected Products/Deliverables:

- Annual data delivery Trip reports providing area estimates of vegetation and general description of status of snails at Vaseys Paradise.
- Contribution to SCORE report

Project B.2. ***Research and Development*– Aquatic Foodbase, Organic Mass Balance, and Foodweb Linkage Program**

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor	N/A	N/A	160,000	220,000	216,000
Logistics Field Support & MPS	N/A	N/A	40,000	40,000	100,000
Project Related Travel/Training	—	—	—	—	5,000
Operations/Supplies	N/A	N/A	18,000	25,000	0
GCMRC Salaries	N/A	N/A	30,000	30,000	79,500
Project Subtotal	—	—	—	—	400,500
DOI Customer Burden (15%)	—	—	—	—	60,075
Project Total	N/A	N/A	248,000	315,000	460,575
% Total Outsourced	N/A	N/A	~79%	~81%	54%

Principal Investigators: Kennedy and others to be determined.

Statement of Problem: River systems are fueled by different sources of organic material that originate from a combination of allochthonous (organic debris from terrestrial environments) and autochthonus production (algae, and macrophytes). These organics serve as the fundamental food source and linkage between aquatic invertebrates and higher level consumers such as fish and waterfowl. The proportion of these organic sources and their overall quantity and quality varies between and within different river systems. Since the closure of Glen Canyon Dam some of the coarser larger organics (woody debris) supplied to the Colorado River are sequestered in Lake Powell. Owing to increased water clarity conditions algal production has become very extensive in the upper river section; however downstream periodic suspended sediment and organic debris supplied from tributaries causes a decline in algal production. The aquatic foodbase is assumed to be both derived from primary production and limited to consumers such as native and endangered fish. Algal production appears to support the major component of the foodbase in the upper river section, yet it remains uncertain whether or not algal production is as important, or as limiting to the downstream foodweb. The aquatic protocol evaluation panel had concerns with the lack of empirically established linkages between food base and fishes, and

identified that a possible consequence of the recent increase in primary and secondary production may differentially benefit non-native species (competitors or predators) over native species. Research and the restructuring of the existing foodbase monitoring program is warranted in light of its importance toward meeting stakeholder objectives.

Summary Project Description: This study will address a number of issues identified by the aquatic protocol evaluation panel. This project focuses on the research and development of an organic budget and foodweb linkage program as an organizational framework to determine whether or not the aquatic foodbase is limiting, and to determine what organic sources, and where limitations occur within the Colorado River system. This requires several approaches: 1) conduct in-stream metabolism and community respiration experiments; 2) quantifying organic and inorganic carbon flux and decompositional rates; and 3) based on findings of the organic mass balance research develop an effective sampling design having the appropriate sampling methods and frequency for assessing and quantifying organic flux (sources, pools, transformations and movement). Sampling will focus on research and development of alternate collecting devices (e.g., Hester-Dendie, drift sample collections) and alternate sample processing techniques during 2005–2007. Sampling will be coordinated with the fisheries and quality of water programs to encourage true linkages of variables collected and variables of biological significance in a food web framework. Request for proposals will be developed during 2005 addressing items above for initiation during 2006. Development of long term monitoring protocols will proceed during 2005-2007 based on the results of research and development during 2005-2006. It is anticipated that a request for proposals to implement a long term monitoring program will be developed in 2008.

MO's and RIN's ADDRESSED: Goal 1; MO's 1.1, 1.2, 1.3, 1.4, 1.5; CMIN's 1.1.1, 1.2.1, 1.3.1, 1.4.1, 1.5.1.

Status/Schedule: Project scheduled for implementation in FY06 and to continue through FY07.

Expected Products/Deliverables:

- Contribution to SCORE report
- Publications on in-stream metabolism
- Publications on organic and inorganic flux and decompositional processes
- Development of an organic mass balance sampling program

- Research, design and feasibility analysis for developing long-term monitoring program.

Integration: (Linkages downstream IQWP and with fisheries)

Project B.3. ***Monitoring*** **- Status and Trends of Downstream Fish Community**

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor	469,000	570,000	596,000	546,000	550,000
Logistics Field Support & MPS	176,000	153,000	150,000	150,000	150,000
Project Related Travel/Training	—	—	—	—	5,000
Operations/Supplies	0	15,000	30,000	30,000	20,000
GCMRC Salaries	28,000	71,000	94,000	94,000	116,500
Project Subtotal	—	—	—	—	841,500
DOI Customer Burden (15%)	—	—	—	—	126,225
Project Total	673,000	809,000	870,000	820,000	967,725
% Total Outsourced	92%	88%	84%	83%	65%

Principal Investigators: Coggins, U.S. Geological Survey, (GCMRC) and technician, U.S. Fish and Wildlife Service, Arizona Game and Fish Department, and SWCA, Inc.

Statement of Problem: The downstream fish community is an assemblage of native and non-native fish that occur in the Colorado River ecosystem. This assemblage is exclusive of the trout fishery that is managed in Glen Canyon by the Arizona Game and Fish Department. The constituents include four native fish and introduced competitors/predators like rainbow trout, brown trout, channel catfish, carp, and other non-native forms. The status and trends of the fishery are regulated by biotic and abiotic mechanisms that may in turn be affected by the operations of Glen Canyon Dam. Monitoring basic population statistics including recruitment, abundance, and distribution of native and non-native fishes provide the fundamental information necessary to assess the status of these resources and the attainment of program goals and objectives.

Summary Project Description: Since 2000, GCMRC and cooperators have been developing a long-term monitoring program for fishes in the CRE. To date, significant progress has been made toward this end such that it is now appropriate for GCMRC to formalize a long-term monitoring program for key non-native fishes (i.e. rainbow trout, brown trout, and common carp). The FY 06 funding recommendation is sufficient to maintain downstream monitoring in the Little Colorado River and in the mainstem for salmonids. Remaining funds will be used to continue development and implementation of the long-term monitoring program as described in the core monitoring plan.

MO's and RIN's ADDRESSED: Goal 2 and 4, MO's 2.1, 2.2, 2.3, 2.4, and 4.2; CMIN's 1.1.1, 2.1.1, 2.4.1, 2.6.1, EIN 2.1.1, 2.1.2, 2.1.3.

Expected Products/Deliverables:

- Annual stock assessment reports for humpback chub and non-native fish.
- Contribution to SCORE reports
- Trip reports following each trip summarizing general catch effort and preliminary results.
- Evaluation of alternative sampling designs that may be tested.
- Data delivery following every sampling trip.

Integration: (Linkages downstream IQWP and with fishery life histories and ecosystem dynamics, distribution and abundance of fishes relative physical habitat elements)

Project B.4. ***Monitoring*** **- Status & Trends of Lees Ferry Trout**

FUNDING HISTORY	Fiscal year			
	2003	2004	2005	2006
Outside GCMRC Science/Labor	90,000	116,000	80,000	90,000
Logistics Field Support & MPS	20,000	20,000	10,000	13,000
Project Related Travel/Training	—	—	—	—
Operations/Supplies	10,000	16,000	10,000	0
GCMRC Salaries	18,000	9,000	11,000	0
Project Subtotal	—	—	—	103,000
DOI Customer Burden (15%)	—	—	—	15,450
Project Total	138,000	161,000	111,000	118,450
% Total Outsourced	78%	83%	85%	87%

Principal Investigators: Persons, Arizona Game and Fish Department

Statement of Problem: The Lees Ferry trout fishery refers to the tailwaters portion of the Colorado River ecosystem managed by Arizona Game and Fish Department. This fishery represents an important recreational and economic resource. This assemblage includes flannelmouth suckers and competitors such as carp. The status and trends of the fishery is linked to the phytobenthic community and to operations of Glen Canyon Dam. Community traits such as spawning and recruitment are influenced by the quality of substrate, water, and food. Competitive interactions between trout and other fish species and among trout may also account for population status. The relationships between operations from Glen Canyon Dam, and the coarse-sediment that forms the spawning substrate and the near shoreline habitat used by young developing trout in the Glen Canyon portion of the Colorado River ecosystem resources are a management concern.

Summary Project Description: Primary method uses electrofishing as the sampling method over multiple nights, which occurs tri-annually. Electrofishing equipment and trained operators are contracted personnel through the GCMRC logistical contract. As of FY01 this monitoring project has used a random stratified sampling approach based on shoreline habitat characteristics for site selection. Nine sites are consistently sampled and linked to past monitoring efforts conducted since 1990. The other remaining 27 sites are randomly selected. Direct and derived

metrics for assessing status and trends are to be reported including CPE, stock assessment, PSD and condition factor of fish.

MO's and RIN's ADDRESSED: Goal 4 and MO 4.1; CMIN's 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.1.5, 4.1.7.

Status/Schedule: Renewal for monitoring status and trends of Lees Ferry Trout are expected to continue for FY04 and FY05. Development of an RFP for monitoring the status and trends of Lees Ferry Trout and technical proposal review are scheduled for FY05.

Expected Products/Deliverables:

- Annual report of status and trends of fishery
- Contributions to SCORE report
- Data delivery following each sampling period.
- Trip report following each sampling period

Integration: (Linkages downstream IQWP and with fishery life histories and ecosystem dynamics, distribution and abundance of fishes relative physical habitat elements)

Project B.5. *HCA* – Concurrent Estimates of Humpback Chub

FUNDING HISTORY	**Fiscal year**				
	2002	**2003**	**2004**	**2005**	**2006**
Outside GCMRC Science/Labor	**NA**	**NA**	**NA**	**NA**	**59,100**
Logistics Field Support & MPS	**NA**	**NA**	**NA**	**NA**	**95,000**
Project Related Travel/Training	**NA**	**NA**	**NA**	**NA**	**0**
Operations/Supplies	**NA**	**NA**	**NA**	**NA**	**0**
GCMRC Salaries	**NA**	**NA**	**NA**	**NA**	**63,500**
Project Subtotal	**NA**	**NA**	**NA**	**NA**	**217,600**
DOI Customer Burden (15%)	**NA**	**NA**	**NA**	**NA**	**32,640**
Project Total	**NA**	**NA**	**NA**	**NA**	**250,240**
% Total Outsourced	**NA**	**NA**	**NA**	**NA**	**27%**

Principle investigators: fisheries biologist U.S. Geological Survey (GCMRC) and cooperators, TBD.

Summary of Problem: Determining population estimates of humpback chub in Grand Canyon is an information need for recovery of humpback chub. Approaches used to determine an estimate vary from in stream concurrent estimates with those done in the Little Colorado River, to model simulations that use the Age Structure Mark Recapture model and other models. The direction of approach remains to be determined at this time. These funds would be used to support either approach with a cost break down provided for field support. In lieu of a field effort these funds would be used for model workshops and information sharing among state and federal agencies. For this effort to be successful would require the full-time attention of a fisheries biologist.

Status/Schedule: Progress in this project is subject to outcomes associated with U.S. Fish and Wildlife Service's workshops being held in 2005.

Expected Products/Deliverables:

- Trip report if a field effort is required
- Data delivery following each sampling period

Project B.6. ***Experimental Treatments*** **- Mechanical Removal of Non-Native Fishes in the Colorado River**

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor	N/A	130,000	130,000	160,000	240,000
Logistics Field Support	N/A	375,000	375,000	375,000	418,000
Project Related Travel/Training	N/A	—	—	—	0
Operations/Supplies	N/A	15,000	15,000	15,000	0*
GCMRC Salary	N/A	66,000	66,000	36,000	30,000
Project Subtotal	N/A	—	—	—	688,000
DOI Customer Burden (15%)	N/A	—	—	—	103,200
Project Total	N/A	586,000	586,000	586,000	791,200**
% Total Outsourced	N/A	54%	54%	59%	96%

*Operations cost for the project in FY06 will be covered through the general logistics within the project.
**Project total for mechanical removal in FY2006 is intended to reflect the actual proposed costs as determined by actual expenditures in FY2005.

Principal Investigators: L. Coggins, U.S. Geological Survey (GCMRC), and B. Persons, Arizona Game and Fish Department.

Statement of Problem: Trends in the abundance and recruitment of the Little Colorado River population of humpback chub suggest this population has been in decline for over a decade. Factors contributing to this decline are unknown but likely include: interaction (predation and/or competition) with non-native fishes, infection by non-native parasites, sub-optimal mainstem water temperatures, hydrological conditions in the mainstem Colorado and Little Colorado Rivers, and decline of near-shore rearing habitat in the mainstem Colorado River. Though it is unknown which factor(s) are most responsible for humpback chub mortality, it is likely that interactions with non-native forms are a contributing element.

Summary Project Description: Following a recommendation from the adaptive management work group (AMWG), the first two years of a long-term experimental design was conducted during 2003-2004. This project subsequently received AMWG approval for continuation during 2005. We anticipate that AMWG will direct GCMRC to continue this project for four years as originally proposed and therefore include it in the 2006 work plan. However, we reiterate the need for this work to accompany implementation of other experimental factors (i.e. Dam Operations and Temperature Modification) in a long-term experimental block design in order to understand the affects of several factors likely to influence humpback chub recruitment. This project addresses one element of that experiment and is designed to provide a better understanding of the interactions between humpback chub and non-native fishes. Additionally, this project addresses the feasibility of non-native fish control in a large segment of the mainstem Colorado River utilizing electrofishing as a method for mechanical removal. During FY-05, the field work component of this project is being conducted through a cooperative agreement with the Arizona Game and Fish Department (AGFD). Contingent on AMWG approval, the cooperative agreement with AGFD will be continued to complete fieldwork in FY-06. A complete study plan is available upon request.

MO's and RIN's ADDRESSED: Goals 2 and 4, MO's 2.1, 2.4, and 4.2.

Consequences of FY06 Funding Recommendations: Increased funding in FY-06 is necessary to account for increased implementation cost as a result of outsourcing this work through AGFD and due to the 15% USGS assessment cost.

Status/Schedule: First and second year field efforts completed. Draft report covering first two years efforts in preparation. Planning for subsequent years underway.

Expected Products/Deliverables:

- Biennial oral reports on project status to the AMWG.
- Interim report in 2005
- Final reports and publications in 2007.

Experimental Component: (Mechanical removal of trout in the main channel during FY03 through FY06)

Integration: (Linkages between recruitment of Humpback chub and abundance and distribution of salmonids in the Marble and eastern Grand Canyon reaches)

Project B.7. Temperature Control Device (to be addressed in next revision)

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor					173,913
Logistics Field Support					
Project Related Travel/Training					
Operations/Supplies					
GCMRC Salary					
Project Subtotal					173,913
DOI Customer Burden (15%)					26,087
Project Total					200,000
% Total Outsourced					100%

C. CULTURAL RESOURCES

Project C.1. Integrated Archaeological Site Monitoring

FUNDING HISTORY	Fiscal year				
	2003	2004	2005	2006	2007*
Outside GCMRC Science/Labor	—	—	17,500	234,420	240,280
Logistics Field Support & MPS	—	—	15,000	80,000	82,000
Project Related Travel/Training	—	—	—	—	1,500
Operations/Supplies	—	—		5,000	9,150
GCMRC Salaries	—	—	7,500	20,720	21,240
Project Subtotal	—	—	40,000	340,140	350,145
DOI Customer Burden (15%)	—	—		51,021	52,520
Project Total	—	—		391,161	402,665
% Total Outsourced*	—	—	63%	81%	81%

* FY06-07 budget figure includes does not include the weather monitoring component. Weather monitoring is a separate budget item, although is an integral aspect of this program.

Principal Investigators: TBD

Statement of Problem: Cultural resources (composed of National Register eligible archaeological sites, cultural landscapes, and places of traditional significance, plus biotic and mineral resources of cultural importance to Native American tribes) are influenced by dam operations and are also affected by physical processes unrelated to dam operations, including visitor activities. Specifically, dam operations directly affect cultural resources through inundation and other stream flow processes. Dam operations also affect these resources indirectly and cumulatively through constraining and managing flows in a manner that prohibits retention of sediment within the channel and adjacent sand bars and by limiting regenerative disturbance processes within the riparian ecosystem. Dam operations control sediment inputs and determine the amount, grain sizes, and elevations of fine-grained sediment deposits, which in turn form the matrix and cover of many archaeological sites in the river corridor. Dam-controlled flows also determine the availability and location of low elevation sand bars, which

provide a potential source of sediment for transportation by wind to higher elevation terraces, where most cultural resources occur.

Monitoring of archaeological sites by NPS archaeologists has been ongoing in the river corridor since the late 1970s. Until the 1990s, the NPS monitoring program focused almost exclusively on visitor impacts to archaeological resources. In 1992, intensive monitoring of cultural resources to determine effects of dam operations began. Monitoring since 1992 has been conducted under the Programmatic Agreement for Cultural Resources. Although these past 12 years of monitoring have documented ongoing erosion of archaeological sites, as well as continuing impacts from visitation, the data have not been collected in a manner that allows amounts, rates and trends of erosion (or visitor impacts) to be tracked and quantified, nor does it allow for the effects of dam-related vs. non-dam-related erosion to be distinguished in a meaningful manner. Monitoring of diverse kinds of cultural resources (archaeological sites, plants, mineral resources) has also been conducted by individual Native American tribes using a variety of field methods.

In 2000, a Protocol Evaluation Panel reviewed the entire cultural program and recommended that the PA monitoring program be redesigned and "reoriented to contribute information to: 1) prioritize historic properties for treatment decisions, and 2) evaluate the effectiveness of treatment options" (Doelle, 2000:8). The panel also recommended that in the future "monitoring should be used in a much more focused manner to document progressive erosion at sites where preservation actions have not been implemented, to assess the effectiveness of particular protection measures, and to ensure that effects of visitor activities remain below a threshold that causes long-term damage" (Doelle, 2000:8). Specific monitoring protocols were not recommended by the PEP. Although the National Park Service instituted some minor changes to their previous monitoring approach as a result of these recommendations, the fundamental issues that prompted the PEP to make these recommendations remain to be addressed.

Summary Project Description: This project will implement new monitoring protocols to quantify the amount and extent of erosion and other types of geomorphic and visitor impacts at a variety of cultural resource sites. This integrated site monitoring program will also assess interactions between dam operations, non-fluvial physical processes, and human activities in

causing or accelerating erosional impacts to cultural resources by directly measuring amounts and rates of geomorphic change at a random sample of sites. Detailed monitoring of geomorphic variables will occur at approximately 40 sites every year, in conjunction with more generalized condition monitoring that will occur at approximately 60 sites per year.

In FY05, GCMRC will host a PEP that will focus specifically on refining monitoring protocols for archaeological sites. National experts in geomorphology, statistical sampling, and cultural resource integrity evaluation will be brought in to review the current program and recommended revisions based on the monitoring objectives defined by the cultural program (stakeholders and GCMRC scientists) as a whole. In FY06, a four year pilot program will be implemented. After the fourth year (2009), the initial results will be reassessed to ensure that the selected approaches are providing the requisite quality and quantity of data necessary to detect meaningful changes within a reasonable time frame.

The proposed long term core monitoring program for archaeological sites will be composed of several interrelated components: 1) archaeological site condition monitoring (approximately 60 sites per year), 2) intensive monitoring of a randomly selected site sample to detect and quantify rates and trends of geomorphic change and to relate these changes to system-wide processes (approximately 40 sites per year), and 3) weather monitoring. (Although closely related to the archaeological site monitoring effort, tribal values monitoring is discussed below under a separate project statement and budget.)

The first two components of this integrated cultural monitoring program are described below as a single project description. The weather monitoring and tribal values monitoring components are included under separate project descriptions, although all components are interrelated and will ultimately comprise a single, integrated program.

Component 1: Site Condition Monitoring: This component involves completing visual assessments of site impacts and overall condition for approximately 60 sites per year. Over a four year period, a total of approximately 240 sites will be monitored. These sites have previously been identified as being potentially affected by dam operations. We will reassess the geomorphic context of each site during the first four year cycle of monitoring and eliminate sites that have no potential for future impacts due to dam operations (e.g., rock art sites on high cliff faces, sites situated in rockshelters above the prehistoric flood plain). The remaining sites will

be divided into three to four groups of 60-70 sites each, and every site in each group will be monitored on an even schedule (approximately once every 3-4 years, depending on the total number of sites remaining in the pool.) Condition and impact information will be recorded according to a standardized format, and the results tabulated to produce an overall site condition index rating that can be objectively compared from one monitoring episode to the next. The recording format will build on the previous NPS monitoring protocols but will incorporate new variables, eliminate redundant variables, and incorporate some new recording methods as dictated by the PEP review. This monitoring component will require to two river trips per year.

Component 2: The second component of the integrated archaeological site monitoring program is explicitly structured to quantify amounts and rates of erosion occurring at archaeological sites in a system-wide sense and establish the nature and extent of linkages between dam operations and archaeological site conditions. Monitoring of a stratified random sample of cultural resources will provide measured data on: (1) rates and amounts of change in the physical conditions of cultural resources; (2) cause-and effect linkages between dam operations and natural physical processes in the ongoing erosion of archaeological sites and other cultural resources; (3) information on system-wide influences of flow regulation on archaeological resources, with specific respect to long-term stability of high elevation fluvially-derived sedimentary deposits.

These objectives will be attained through selecting a stratified random sample of approximately 40 sites from the total population of sites included in Component 1. The site population will be stratified by a constellation of geomorphic attributes, using the Thompson and Potochnik model (or some other scheme recommended by the PEP) as the basis for stratification. Stratification ensures that the sample of monitored sites covers a broad range of geomorphic settings within the CRE, while randomization ensures that sites will not be pre-selected on the basis of assumed rates/amounts of ongoing erosion. This sample of sites will be subject to repeat mapping, using state-of-art mapping technologies tied to geo-referenced controls. Measurements will be geared towards tracking geomorphic changes through time in order to determine trends in resource status. Specific monitored attributes will include volumetric (topographic) change, nickpoint migration, channel thalweg evolution/incision, and channel cross section widening. The mapping component of the long-term monitoring program will

require an additional two trips per year, focused exclusively on repeat mapping of the sample sites.

Component 3: Linking observed changes in resource condition to dam operations and other geomorphic drivers in the system requires that observed changes in resource condition be assessed in relation both to ongoing dam operations, as well as regional climatic processes and localized weather events. The current monitoring program documents evidence of active and inactive site erosion, but has no way of evaluating those data in a meaningful context. Without a weather context with which to evaluate this information, the data remain uninterruptible.

The proposed weather monitoring component of this project--although presented as a separate monitoring program with broad applications to diverse resources within the CRE—will be integral to the success of a long term intensive monitoring effort for cultural resources, as it will allow us to begin to establish the various cause-and-effect relationships between dam operations, weather events, and observed changes in physical conditions at individual archaeological sites. (At the present time, weather monitoring is NOT included in the FY06 budget.)

MO's and IN's ADDRESSED: Goal 11, MO 11.1; CMINs 11.1.1, 11.1.2, 11.1.3a, 11.1.4 and 11.2.1 (also RINs 11.2.2 and 11.2.4).

Consequences of FY05 - 06 Funding Recommendations: FY06 will be the first full year of what will be the long term core monitoring program for cultural resources focused on addressing the mandates of the Grand Canyon Protection Act, as well as meeting the needs for cultural resource monitoring under NHPA. Field implementation in FY06 will be preceded by a cultural monitoring PEP during FY05.

At the present time, the weather monitoring component is not included in the FY06 budget. The lack of local weather data will preclude our ability to determine cause-and-effect relationships between local weather events, observed erosion at archaeological sites, and dam operations. However, we will still be able to gather measurements on rates and amounts of erosion, which will constitute a significant improvement in the overall scientific quality of the cultural program data.

During FY's 2007-2009, this core monitoring effort will continue. After FY09, the program will be re-evaluated and refined, if necessary.

Status/Schedule: FY05 – Convene review committee to develop and refine specific protocols for quantitatively monitoring changes in the condition of cultural resources and linking observed changes to dam operations. FY06 – 09 pilot the protocols and reassess their effectiveness for detecting change. Refine protocols as necessary.

Expected Products/Deliverables:

- Map products including detailed topographic maps, longitudinal survey profiles of gully thalwegs, measured channel cross sections, and accompanying technical reports
- Annual reports, documenting changes in the condition of monitored resources
- Digital files of all maps, photographs, and raw monitoring data resulting from the field effort, plus all analyzed data sets.
- SCORE report and peer-reviewed journal articles documenting influences of dam releases on the status and long-term condition trends of cultural resources in the Colorado River ecosystem.

Project C.2. Integrated Tribal Values Monitoring

FUNDING HISTORY	Fiscal year				
	2003	2004	2005	2006	2007*
Outside GCMRC Science/labor	—	—	—	250,000	—
Logistics Field Support	—	—	—	0	—
Project Related Travel/Training	—	—	—	0	—
Operations/Supplies	—	—	—	0	—
GCMRC Salary (student intern)	—	—	—	25,000	—
Project Subtotal	—	—	—	275,000	—
DOI Customer Burden (15%)	—	—	—	41,250	—
Project Total	—	—	—	316,250	—
% Total Outsourced	—	—	—	91%	—

*logistical costs are covered through tribal river trips and participation with NPS archaeological site monitoring trips

Principal Investigators: TBD

Statement of Problem: The five tribal groups participating in the Glen Canyon Dam Adaptive Management Program have cultural traditions associated with Grand Canyon that extend back many hundreds, and perhaps thousands, of years. Many of the same resources are valued by

multiple tribes for different reasons. Resources valued by the tribes include many of the same prehistoric and historic sites that are also valued by the National Park Service and the general public for their informational and potential interpretive values. In addition to archaeological sites, the tribes place value on a number of specific locations (geologic landmarks, springs, shrines) in the CRE that they identify as being important to their traditional cultures. Many of the sites and landmarks qualify as traditional cultural properties under the National Historic Preservation Act, although formal determinations of eligibility have not been completed. Other resources valued by the tribes included a broad suite of plants and animals (particularly those found in proximity to archaeological site and TCP areas) and minerals. Numerous native plant and animal species in the CRE have been identified by the Southern Paiute, Navajo, Hualapai and Hopi people as having significant cultural value because they were traditionally or are currently used in ceremonies, as medicines, and in daily living. (Jackson, 1993; Lomaomvaya, 1999; Southern Paiute Consortium and Bureau of Applied Research, 1997). Above and beyond these individual resources, however, the Tribes value Grand Canyon as a whole for its uniquely important role in their traditional histories and spiritual lives.

Since the mid 1990s, three of the five tribal entities participating in the AMP (Southern Paiute Consortium, Hualapai, and Hopi) have monitored some of their traditionally-valued resources at selected locations in the river corridor in conjunction with annual tribal river trips funded by the DOI agencies through the AMP. Like the current historic property monitoring program, the purpose and rationale behind most of the current tribal monitoring programs has not been made explicit. Methods are highly variable between the various programs, and the data being gathered and reported are not always clearly tied to the needs of the AMP for information on the effects of dam operations.

Systematic monitoring of register-eligible TCPs is currently hampered by the lack of a formal inventory and evaluation of tribal TCPs within the CRE. Because TCPs are highly variable in nature, ranging from unmodified natural landmarks to humanly crafted structures and from very small areas to extensive expanses of terrain, it is necessary to identify the TCPs and their values, at least in a general sense, in order to devise appropriate monitoring strategies. The identification and evaluation of TCPs must be carried out by the community that values these resources, as the resource values are in many cases, tribally (culturally) specific. Many Native American communities are reluctant to identify TCPs for fear that these places will be co-opted

or desecrated by ignorant or insensitive people. It is nevertheless necessary to identify TCP values in a general sense in order to ensure that monitoring and management approaches are relevant and sensitive to the particular resources of concern.

In 2001, GCMRC attempted to engage the Tribes in the development of a long-term terrestrial ecosystem monitoring program (TEM) to incorporate tribal needs for information about non-Register eligible plant and animal resources of cultural importance. This attempt met with only limited success. Although representatives from Southern Paiute, Hualapai, and Hopi attended most of the TEM meetings, and representatives from Hopi and the Kaibab Band participated on TEM river trips, only the Hopi Tribe provided specific input to GCMRC about how current data collection strategies could be modified or supplemented to meet their specific needs for information. Hualapai and Southern Paiute representatives indicated that their needs could be met through the TEM program as currently designed, because the resources of interest to them are tied to specific locations in the river corridor, while the TEM program relies on a randomly selected sample of study sites, none of which overlap with their specific locations of interest.

Regardless of the final TCP inventory and evaluation results, future monitoring of tribally-valued resources needs to be explicitly linked to the goals of GCPA and the needs of the AMP for current information on the status of resources relative to dam operations. Currently, three of five tribal entities engaged in the AMP are conducting monitoring programs of one kind or another in the CRE. Most of these programs monitor one or more tribally-identified TCPs, plus archaeological sites, and plant and mineral resources. The upcoming (FY05) Traditional Values and Science Integration workshop will assist the tribes in refining their current monitoring programs in spring FY05 to articulate with the needs of the AMP for tribal feedback on resource conditions. GCMRC will work with the tribes to provide guidance on implementing the workshop results and modifying current protocols as necessary to meet the specific needs of the GCD-AMP.

Management Objectives Associated with Cultural Resources

MO #	Objective
11.1	Preserve historic properties in the area of potential effect via protection, management, and/or treatment (e.g. data recovery) for the purpose of federal agency compliance with NHPA and AMP compliance with GCPA.

11.2	Preserve resource integrity and cultural values of traditionally important resources within the Colorado River Ecosystem.
11. 3	Protect and maintain physical access to traditional cultural resources through meaningful consultation on AMP activities that might restrict or block physical access by Native American religious and traditional practitioners.

CMIN #	**Question**
11.1.1	Determine the status of historic properties under Record of Decision operations. (11.1.1a Determine periodically whether the essential physical features are visible enough to convey their integrity or retain their information potential)
11.1.3	What are the thresholds for impacts that threaten the integrity and eligibility of historic properties? (11.1.3a Are the current monitoring programs collecting the necessary information to assess resource integrity?)
11.1.4	How effective is monitoring, and what are the appropriate strategies to capture change at an archaeological site – qualitative, quantitative?
11.2.1	Are the traditionally important resources and locations for each tribe and other groups being affected?

Proposed Program: Tribal monitoring protocols for traditionally valued resources will be developed through the upcoming Traditional Values and Western Science Integration workshop. The tribes will work with research collaborators from Northern Arizona University to assess their current programs in terms of their relevance to GCPA and the AMP goals as well meeting tribal information needs, and to ensure that they address the CMINs identified in the AMP strategic plan. Tribes will be asked to articulate rationales for using specific approaches and methodologies, as well as generic values of resources that they consider important to monitor and preserve. For example, if a tribe is concerned with preserving native plant diversity at certain culturally important locations in the river corridor, a monitoring strategy that is specifically designed to measure and track the proportion of native vs. non-native plants at those locations needs to be developed. On the other hand, if a tribe is concerned with tracking the abundance of a specific plant or animal species on a system-wide basis, then a different monitoring approach is required. The first step is for the tribes to define the values of interest to them and articulate the specific parameters that must be monitored in order to determine whether those values are being retained, degraded, or enhanced under current dam operations.

Tribal monitoring programs will be piloted in FY06. To the extent possible, field-based tribal monitoring efforts will be integrated with ongoing archaeological site monitoring trips to reduce overall trip numbers while improving communication and integration of cultural monitoring activities across program boundaries. Integration of tribal monitoring activities with

archaeological site monitoring makes good sense, both economically and programmatically, because the tribes are interested in monitoring many of the same locations that are currently monitored by NPS archaeologists, although they do not necessarily want to monitor the same attributes at these locations. By combining field efforts, we hope that the amount of human (monitoring-related) impact to fragile archaeological areas can be minimized and communication and exchange of ideas across internal cultural program boundaries improved. The tribes will continue to receive funding for at least one river trip per year, during which time they can monitor particularly sensitive locations independently and consult with tribal elders in private.

Project C.3. Integrated Campsite Monitoring Program

FUNDING HISTORY	Fiscal year					
	2002	2003	2004	2005	2006	2007
Outside GCMRC Science/Labor	—	—	—	—	141,040	144,566
Logistics Field Support & MPS	—	—	—	—	40,000	41,000
Project Related Travel/Training	—	—	—	—	0	0
Operations/Supplies	—	—	—	—	6,000	6,150
GCMRC Salaries	—	—	—	—	6,000	6,150
Project Subtotal	—	—	—	—	193,040	197,866
DOI Customer Burden (15%)	—	—	—	—	28,956	29,684
Project Total	—	—	—	—	221,996	227,550
% Total Outsourced	—	—	—	—	83%	83%

Principal Investigators: TBD

Statement of Problem: Campable areas in the CRE are diminishing in size, quality and overall number under current dam operations (Kaplinski et al., 2003; NPS, 2005.) In the early 1980s, growing public concern over diminishing size and quality of camping opportunities in the CRE and the impact of proposed changes in dam operations on "camping beaches" was one of the critical issues that prompted the Bureau of Reclamation to initiate the Glen Canyon Environmental Studies program.

The loss of campable area in the CRE impacts visitor use values in a variety of ways. The number, size classes, and distribution of campsites are critical for maintaining the types and quality of recreational opportunities consistent with National Park Management objectives (NPS, 2004). These three critical factors--number, size, and distribution--constrain the upper limits of the Colorado River corridor's visitor carrying capacity (NPS, 2005). A diminishing quantity and range of camping opportunities negatively impacts visitor experience through increasing crowding, increasing numbers of contacts between groups, and increasing human use-related impacts (an end result of large numbers and large groups of recreational users being forced to camp in increasingly smaller areas.) Moreover, some specifically-valued campsite qualities such as amount and spatial distribution of open sand area, boat mooring attributes, and availability of shade (Stewart et al., 2000) are directly influenced by dam operations.

Repeat surveys of a non-random sample of camping areas in the CRE shows a continual downward trend in campsite area (Kaplinski et al., 2004.) As sand bars continue to decline in size, elevation, and distribution, recreational users "pioneer" new camps in the old high water zone. Visitors also "pioneer" new camps in the New High Water zone by deliberating breaking or cutting back vegetation or by modifying the landscape in other ways. These impacts are contrary to the Grand Canyon National Park's long-term management objectives for the Colorado River corridor.

The relationship between operations of Glen Canyon Dam and camping opportunities in the river corridor has been studied over the course of the last three decades, using a variety of assumptions and approaches (Borden, 1976; Brian and Thomas, 1984; Brown and Hahn-O'Neill, 1987; Kearsley and Warren, 1993; Kearsley et al., 1994, 1995, 1994; Shelby et al., 1976, 1992; Stewart et al., 2000; Kaplinski et al., 2004; see also Behan, 2000 and Kaplinski et al., 2003 for a summary of past recreation monitoring and research approaches pertaining to the Colorado River in Grand Canyon.) Recent monitoring shows that sand bar camp size and opportunities have decreased through time as sediment has been removed from the system by dam operations (Kaplinski et al., 2004).

Decreases in total amount of campable area are also due to vegetation encroachment (Kaplinski et al., 2004.) The lack of periodic scouring floods under current dam operations has allowed vegetation to become established on many formerly open sand areas. Vegetation encroachment is believed to be an important factor contributing to the reduction in size and

abundance of campable areas in the CRE, yet actual rates and amount of campsite loss due to vegetation encroachment remain unmeasured and unknown (Kaplinski et al., 2003, 2004).

The National Park Service currently monitors approximately 100 campsites for visitor related impacts such as social trailing, vegetation damage, fire scars and litter. NPS recently initiated a new pilot campsite impact monitoring program to meet Park-specific management needs related to the Colorado River Recreation Management planning process. The current NPS recreation monitoring programs are primarily concerned with tracking human impacts at campsites, rather than focusing on physical changes linked to dam operations. The current NPS monitoring program will continue into the foreseeable future as a separate but complementary program to the one presented here. The AMP currently does not have a well conceived, integrated campsite monitoring program that is fully responsive to stakeholder needs.

Despite more than 30 years of research on Grand Canyon river corridor campsite issues, an up-to-date, comprehensive inventory of camping areas in the river corridor is currently lacking (Kaplinski, 2003). Such an inventory is needed to provide a comprehensive baseline record of campsite number, distribution, and size in the CRE, from which changes and trends in physical conditions can be objectively compared and tracked over time. In addition to a comprehensive inventory (list) of all camps, we also need a ground-truthed record of current camp area, so that changes in area, vegetation growth, and related-social impacts can be tracked and measured over time.

A long-term campsite monitoring program is essential for tracking both long-term and short-term impacts, as well as cumulative effects of current dam operations on camp-based visitor use values in the CRE. Currently, the only AMP-sponsored campsite monitoring program is funded and conducted on an *ad hoc* basis. The current program serves to define one important component of the visitor use equation: overall change in the amount of suitable camping area (extrapolated from repeat surveys at approximately three dozen popular campsites). A more comprehensive and integrated approach, as proposed here, will track system-wide changes in the numbers, distribution and qualities of the camping resource over time, using primarily remotely sensed data collected as digital imagery once every four years, coupled with repeat survey and photographic data.

Summary Project Description: This campsite monitoring program is designed to track and quantify trends in the size, distribution, and physical qualities of recreational camping

opportunities in the CRE, using a combination of remotely sensed and field-based data. This project will build on the current (FIST) campsite area survey program and integrate it with complementary data derived from remotely sensed vegetation and sediment (digital imagery) data. The long-term photographic record produced by the Grand Canyon River Guides Adopt-a-beach program will continue to provide a long term, site specific visual record of campsite changes, to complement the more generic assessments accomplished through analysis of remotely sensed imagery. In addition, we will complete a comprehensive inventory (geo-referenced maps) of current camping areas and transfer these maps to a GIS, which will serve as the foundation for monitoring system-wide changes in campsite size, distribution and quality through time.

The baseline GIS-based inventory will serve as the foundation for the long-term core campsite monitoring program. Once the baseline inventory of camp sites is in place (a two-year process), we will be positioned to use remotely sensed imagery to make system-wide assessments of changes in camp site size, distribution, and quality over time in relation to ongoing dam operations. During the first two years of this project, we will compile the results of all previous camp sites inventories into a GIS, integrating legacy campsite data with information derived from a recent remotely sensed campable area initiative (Breedlove, 2003), coupled with on-the-ground maps of current campsite areas. Current use levels will be established through surveys of current recreational users, and compared with use level data from prior studies. Prior inventory data will be validated and refined through field inspections, as necessary.

GCMRC and NPS recreation management staff will collaborate to define campsites boundaries from a management perspective (i.e., NPS staff will define what they consider to be the acceptable boundaries of each camp). We will also document all areas currently used for camping, including areas that NPS considered to be "out-of-bounds," based on physical evidence of prior use and river runner survey data.

The specific (interrelated) components of this project include the following:

1) The current program of repeat mapping of campable area at a judgmental sample of sand bar camps will continue, while we transition to more use of remotely sensed data.
2) Aerial photo-based inventories by Weeden et al. (1975), Brian and Thomas (1984), and Kearsley and Warren (1993) will be compiled into a single GIS. The quality and

collection methods of this pre-existing aerial photo data will be evaluated, then transferred to one set of orthorectified digital imagery in a spatially referenced GIS.

3) We will comprehensively inventory all campsites currently used by river runners in the river corridor. We will supplement the existing inventory data (now somewhat out of date) with information derived from recent commercial guidebooks (e.g. Martin and Whitis, 2004) and by interviewing commercial guides and science outfitters to identify all actively used locations. We will combine the geographic information with past and current NPS assessments of the maximum group size considered appropriate for each identified campsite.
4) With NPS collaboration, we will outline current camp sites areas on orthorectified images in the field using the pen tablet approach pioneered by Kaplinski et al. (2003). Important attributes of camp sites will be coded in linked data fields (e.g., type of camp: bedrock ledges vs. open beach, percentage of total area covered by sand vs. vegetation, boat mooring characteristics, etc).
5) We will compare currently used camp sites with formerly identified sites to determine changes in type, distribution and (where possible) size of camp sites over the past thirty years.
6) We will compare currently used camp sites with campable area polygons derived from analysis of remotely sensed data (Breedlove, 2003). As part of this effort, we will also thoroughly evaluate the limitations and benefits of using remotely sensed data to track changes in various attributes at various types of camp sites through time.
7) We will track and quantify amounts and rates of vegetation encroachment at campsites. Vegetation encroachment will be measured at camps currently being monitored by NAU, as well as at key Adopt-A-Beach sites, plus at a random sample of all CRE camp sites (selected from the total population of camp sites identified through the inventory). We will directly measure vegetation encroachment via repeat comparisons of remotely sensed, digital imagery. (The digital imagery data will be gathered once every four years, but analysis of the data will be ongoing throughout the intervening period.)

8) To supplement the remotely sensed vegetation and beach area data, we will continue to gather and maintain a visual record of campsite changes using volunteer labor provided through the Grand Canyon River Guides' Adopt-A-Beach program.

MO's and IN's ADDRESSED: Goal 9, MO's 9.1, 9.3; CMINs 9.1.1, 9.1.2, 9.1.3, 9.3.1, 9.3.2; EIN 9.3.1.

Consequences of FY06 Funding Recommendations: This long-term monitoring project should be a high priority for implementation in FY06. FY06 presents the first opportunity to implement the project.

Status/Schedule: FY06-09: This multi-year project will begin in FY06. The first two years will emphasize collection of baseline campsite data and refining methods for calculating sand area and vegetation change. Collection of system-wide digital imagery will occur in FY06; analysis of this digital data set will continue through FY09. This project builds upon and integrates the previous work of Kaplinski et al. (2004), Breedlove (2003), and the ongoing Adopt-A-Beach effort.

Expected Products/Deliverables: A series of GIS layers composed of 1) previously inventoried camp sites tied to spatially-referenced digital imagery, 2) current campsites with NPS management boundaries and actual use areas delineated; 3) inventory of potentially campable sand areas (based on remote sensing analysis); 4) vegetation. GIS data will be complemented by the long-term visual (photographic) record of campsite changes derived from the ongoing Adopt-A-Beach Program. A thorough GIS-based analysis of these data will be conducted to 1) document changes in type, distribution and size (where feasible) of camp sites over time, and 2) document encroachment of vegetation on campable areas. We also hope to establish the reliability of using remotely-sensed data to predict future camp site locations.

Integration: This project integrates vegetation monitoring, sand bar area monitoring, and repeat photo monitoring into one, integrated campsite monitoring program. This project also integrates remotely sensed data with legacy data derived from conventional aerial photos into one GIS, and it ultimately builds our capacity to link the physical attributes of camp sites to experiential parameters that are important for tracking effects of dam operations on other visitor use values.

D. LOGISTICS OR SUPPORT SERVICES PROGRAM

Project D.1. Coordination and Support Program-Logistics Operations

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Operations/Supplies (direct funded)	—	—	—	—	100,000
GCMRC Salaries (direct funded)	98,300	121,000	121,000	125,000	59,700
Direct Funded Subtotal	—	—	—	—	159,700
DOI 15% Customer Burden	—	—	—	—	23,955
Direct Funded Total	—	—	—	—	183,655
Outside GCMRC Science/Labor	537,000	402,000	406,000	444,000	478,000
NPS Permit Processing	57,000	72,000	76,000	97,000	100,000
Outside GCMRC Subtotal (Project Funded)	—	—	—	—	578,000
Operations/Supplies (Project Funded)	70,000	210,000	222,000	240,000	120,000
Project Total	762,300	805,000	825,000	906,000	881,655
% Total Outsourced	78%	59%	58%	60%	67%

Notes: [1]Project Funded dollars are deducted from applicable projects where the burden has been calculated. They are shown here to demonstrate the proportion of work that is completed by non-GCMRC individuals.
[2]All Logistics Operations/Supplies costs are distributed to GCMRC projects based on a formula proportional to use of services. The formula takes into account contractor costs, trip size and length, and a percentage of operating expenses, salaries and permitting costs.
[3]In FY2005 the logistics coordinator position became part of the Program Manager's position over seeing logistics, survey and control network. In FY2006 the Program Manager's salary will be included under the Program Planning and Management category (F.2).

Principal Investigators: Carol Fritzinger and Parke Steffensen

RIN'S ADDRESSED by this Project: The Logistics Program provides support to the GCMRC science programs and the adaptive management program.

Program Description: Implementation of the GCMRC mission to provide credible, objective scientific information to the AMP begins with effective coordination of all technical and logistical support of research activities. The Research Coordination and Support Program staff functions as a team to facilitate collaboration with the Integrated Science and Cultural Programs through effective communication with Program Managers, PI's and the Technical Support Services. The program encompasses the integration of 5 elements:

- Permitting
- Library Operations Coordination
- Survey Support Coordination
- Technical Support Coordination
- Logistics Operations

Program Staff address each of these elements in assessment of support requests from researchers to determine which tools and processes will best facilitate the most effective collection and delivery of information from research projects. Through the combined effort of the program elements the process of research support is executed as a complete and fully integrated support service. The process is initiated in the proposal review and permitting stage, continued through the support coordination stage and completed with information delivery and report. The process acts as an accountability checkpoint, failure to meet agreed data collection and delivery standards is addressed immediately and corrective solutions are sought to avoid any delay in project completion.

Summary Project Description: The GCMRC provides complete logistical support for 35-50 research, monitoring and administrative river trips through the Grand Canyon annually. These trips range in length from 7 to 21 days and from 4 to 36 people in size. Trips are comprised of a variety of motor and oar powered boats operated by contracted boat operators. Projects operating in the Glen Canyon reach of the Colorado River (Glen Canyon Dam to Lee's Ferry) are supported by a variety of motor powered boats operated by GCMRC researchers and contracted boat operators. Additionally, research activities on the Little Colorado River and at other locations outside of the Grand Canyon National Park boundaries are supported by helicopter services contracted with the Bureau of Reclamation. Ground based support for other research activities outside of the river corridor are also coordinated with the use of GCMRC leased vehicles.

The GCMRC uses a method of supporting trips in which government owned boats and river logistical equipment are used in conjunction with a contracted vendor who supplies Technical and Logistical Boat Operators. A concerted effort is made to match PI's with the best possible Boat Operators for their particular study. Food packs, trip supplies, and equipment are organized, packed and maintained at the GCMRC warehouse. Put-in and take-out transportation is provided with the use of GSA leased vehicles and contracted shuttle drivers.

This logistical approach has evolved since the GCES phase to allow a detailed overview of trip particulars that most influence cost and efficiency, ultimately giving the GCMRC control over trip costs and productivity. Effective communication with PI's and sensitivity to and awareness of the challenges they face in implementing their studies enable the GCMRC to offer more customized (and therefore more cost-effective and productive) logistical support than other support strategies utilized previously. Retaining control over the process of supporting trips also facilitates compliance with NPS regulations and allows greater control over issues sensitive to the general public and the "recreational river community."

Schedule: The trip planning and scheduling process begins in the fall when the Logistics Coordinator, in cooperation with contracted PI's, Program Managers and the Research Coordination and Support Staff work together to generate a draft schedule of trips for the fiscal year. The schedule includes; launch and take-out dates, numbers of personnel and specific boat and boat operator requests for each trip. Researchers must submit a Trip Request Form a minimum of 60 days prior to the scheduled launch date. This form provides information for two purposes: 1) determine and schedule logistical and support services and 2) complete a GCNP River Trip Application in order to meet the GCNP 45 day deadline for submitting access permit applications. The schedule is implemented throughout the fiscal year. Project cost distribution is determined at the close of the fiscal year.

Consequences of FY05 Funding Recommendations: The Logistics Budget represents the funding required to support all research and monitoring projects in the 2005 work plan. Any reduction in funding will result in inability to provide logistical support to projects as proposed.

Project D.2. Survey Operations

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor	0	0	33,000	0	0
Logistics Field Support & MPS	0	0	12,200	45,200	40,000
Operations/Supplies (includes equipment)	35,000	36,000	36,800	68,800	28,150
GCMRC Salaries	35,550	41,180	44,000	44,000	61,000
Project Subtotal					129,150
DOI 15% Customer Burden	70,550	77,180	126,000	158,000	19,373
Project Total	0	0	26%	0	148,523
% Total Outsourced					0%

Principal Investigators: Kristin Brown, U.S. Geological Survey (BRD- GCMRC)

Rationale: GCMRC's survey department supports the research needs of the scientists and includes acquiring topographic data, positioning remotely sensed data, evaluating innovative mapping techniques supporting research goals, validating accuracy of topographic and spatial data, compiling historical data, as well as, updating positions for historical topographic and spatial data for inclusion into the GIS database. For inclusion into the GIS database, the spatial data must be referenced to the geodetic control network which provides highly accurate real-world coordinate values from which measurements computing change are calculated. Referencing historical, current and future data to the control network ensures that the data are in a common reference system, and are comprised of the most accurate coordinate values available for ecosystem monitoring studies, research and inclusion into the GIS database for analysis.

The survey support offered by GCMRC allows for consistent data collection methods by technically trained personnel familiar with the surveying equipment and the logistical constraints of Grand Canyon fieldwork. The survey department also develops and performs consistent storage and database protocols for all survey data collected in the CRE for simple integration into the GIS database.

Statement of Problem: Grand Canyon Monitoring and Research Center (GCMRC) is charged with providing credible, objective scientific information to the Glen Canyon Dam Adaptive

Management Group on the downstream resources of the Colorado River using an ecosystem wide approach. This approach requires that physical, biological and cultural spatial data be integrated into a regional Geographic Information System (GIS) database to allow for accurate, long-term change detection analysis of CRE resources and for interrelationship analysis between CRE resources. All spatial data collected under the direction of the GCMRC requires referencing to the geodetic control network established by the National Geodetic Survey and the GCMRC. The geodetic control network is the framework for the entire Geographic Information System Database (GIS). Accurate positioning of the spatial data allows for accurate change detection computations including volumetric and surface area computations. The trained GCMRC Survey staff supports research and monitoring activities by collecting survey data following survey protocols, and by delivering the data in the formats consistent with data standards. The survey staff maintains survey equipment for field use including conventional total station equipment, static, kinematic and Real Time Kinematic (RTK) GPS equipment, digital cameras, echo sounders, acoustic Doppler and bathymetry systems, and field maps for resource identification.

Summary Project Description: The survey department has several responsibilities. First, the control point database must be populated and verified to serve as a reference for positioning current and future field data, as well as a reference for updating historical data for inclusion in the GIS database. Second, the survey department assists the researchers collect the field measurements for scientific investigations, following protocols that ensure researchers, contractors, and staff, achieve accurate spatial data with realistic error assessments for reliable data analysis and database integration. Furthermore, the survey department advises researchers on the appropriate methods of collecting topographic or spatial data to meet the requirements of a scientific study. Finally, the survey is responsible for obtaining, maintaining and upgrading all survey equipment necessary to meet the needs of the researchers.

Survey operations in support of programs within GCMRC are divided into the following areas:

1) Positioning of historically and newly collected spatial data.
2) Reference historical spatial data to modern control network.
3) Populate the Control Point Database.
4) Quality Assurance/ Quality Control of spatial data.
5) Evaluate innovative mapping techniques
6) Maintain and upgrade equipment

Recommended Approach and Methods: Control points are established and spatial data is collected using both GPS and conventional survey methods. Surveys follow protocols developed by GCMRC with technical support from the National Geodetic Survey, Army Corps of Engineers, and the Federal Geodetic Data Committee.

Integration: All programs within the GCMRC require spatial data measurements. Integration with each program's requirements and the GIS database is imperative to the process of survey data collection, post-processing, storage, and evaluation. The survey department is available to all GCMRC principal investigators and can often collect data for multiple projects during the same mission.

MO's and IN's ADDRESSED: Goals 4, 5, 6, 7, 8, 9, 11, and 12, MO's 4.1, 4.2, 5.1, 5.2, 6.4, 7.3, 8.1, 8.2, 8.3, 8.4, 8.5, 9.3, 11.1, 12.2, 12.3, and 12.9

Consequences of FY05 Funding Recommendations: Funding will allow for more historical datasets to be integrated into the GIS database for accurate change detection with GIS tools. Additional funds will be preserved by attaining accurate positions and elevations of spatial data prior to integration into GIS database.

Status/Schedule: FY2001- Low Summer Steady Flows, Kanab Amber Snail, Channel Mapping

FY2002- Fine-grained Sediment Team, Cultural Mitigation, Kanab Amber Snail, Remote sensing support
FY2003- Remote sensing support, Cultural Mitigation, Kanab Amber Snail
FY2004- Physical resource historical data sets, Colorado River Ecosystem Elevation Database, Fine-grained Sediment Team, Kanab Amber Snail, Colorado River Ecosystem Elevation Database, remote sensing support
FY2005-6 Physical resource historical data sets, Cultural resource historical datasets, cultural mitigation, Kanab Amber Snail, Colorado River Ecosystem Elevation Database, remote sensing support

Project Goals and Objectives:

1) Supply GCMRC principal investigators with the necessary equipment, supplies, and survey knowledge to perform the spatial data collection required by their research.
2) Publish updated control point coordinates, superseded coordinates, and associated error estimates for all network control. This will be done through the development of the GCMRC control point database and made available to Grand Canyon National Park and all CRE researchers.

3) Publish control point maps and make them available for all CRE field survey activities
4) Publish and populate the descriptions in the Control Point Database.
5) Continue translating and rotating historical survey data sets to updated network control coordinates
6) Integrate the prioritized historical survey datasets into the CRE database
7) Educate principal investigators and researchers regarding the limits of various mapping techniques.
8) Evaluate innovative mapping techniques supporting research goals

Project D.3. Geodetic Control Network

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor			0	50,000	0
Logistics Field Support & MPS			54,000	52,000	40,000
Operations/Supplies			10,000	20,000	51,150
GCMRC Salaries			22,000	33,000	62,600
Project Subtotal					153,750
DOI Customer Burden (15%)					26,063
Project Total			86,000	150,000	176,813
% Total Outsourced			0%	22%	0%

Principal Investigators: Keith Kohl, U.S. Geological Survey (BRD- GCMRC)

Rationale: The geodetic control network serves as the foundation for all spatial measurements necessary for long term monitoring. This control network also serves as the spatial framework for the Geographic Information System (GIS). The referencing of spatial data must be consistent in order to perform accurate change detection. All spatial data collected within the CRE requires georeferencing to the primary geodetic control network established by the GCMRC and the National Geodetic Survey. While current remote sensing and long-term monitoring sites have been referenced to this network, additional GCMRC monitoring activities require expanded network control efforts.

Statement of Problem: The geodetic control network serves as the spatial framework for the entire Geographic Information System Database (GIS). Discrepancies of control point coordinates affect both the surveys that reference these coordinates and the spatial data analyses performed with available GIS tools. These discrepancies exist, mainly in the vertical component, due to complications of deflection of the vertical, local gravitational anomalies, satellite signal multipath errors, and the combination of conventional measurements, which reference gravity, with GPS measurements, which reference a geocentric ellipsoid. It is the geoid that provides the connection between terrestrial and GPS surveys and it is the geoid that, at this time, is undefined within the complex topography of Grand Canyon.

Summary Project Description: The geodetic control network in Grand Canyon requires both survey operations for research and survey operations for program support. Research is required to better understand the vertical accuracies associated with the Grand Canyon control network. The National Geodetic Survey is pursuing height modernization efforts that will allow for more accurate height systems. Current NGS-funded geodesy research is concentrating on the gravitational effects on heights and geoid computations within the Grand Canyon. The Grand Canyon was selected as a study area to determine the effects of terrain in an extreme and computationally challenging topographic setting. Results from this research will immediately assist GCMRC in the accuracy assessment of CRE control and will potentially contribute to height modernization projects throughout the world.

It has been shown that horizontal positions can be efficiently attained with the use of GPS techniques. While the vertical component is more problematic, heights referencing the ellipsoid can be effectively calculated throughout much of the CRE. These horizontal and vertical coordinates are required for previously collected data sets prior to inclusion in the CRE Oracle database. Coordinates are also required for control in areas of future data collection to eliminate the need to translate and rotate surveys collected in local or historical coordinate systems. Substantial project cost savings are achieved when the geodetic control is established within study areas prior to field data collection in support of monitoring and research projects.

QA/QC is required for all remotely sensed spatial data sets. The Photo-identifiable Fixed Point Database is designed to give positions and elevations at visible “hard points” along the river corridor. This dataset can be used to check accuracy of LiDAR and digital aerial photography (ISTAR) remote sensing techniques, both on a canyon wide basis and for a local

assessment of positional and elevational accuracies of each day's flight. With the high cost of remote sensing data collection, QA/QC is critical to analyzing the usefulness of each data subset. Additionally, this elevation database can also be used to georeference scanned photos from previous missions to study change detection.

Recommended Approach/Methods: Control points are established using both GPS and conventional survey methods. GPS techniques utilize relative positioning where antennas and receivers are placed at both known and unknown network positions. Distances are measured between the known and unknown points by time dependant calculations from GPS satellite data. Conventional survey techniques involve the use of a total station (a survey instrument which combines the horizontal and vertical angle measurement abilities of a transit with electronic distance measurements). Conventional traverse surveys begin at a known reference point, measure through a series of line-of-sight stations, and close at either the point of beginning or another known reference point. Both conventional and GPS measurements will be required for 1) coordinate determinations of positions and elevations throughout the CRE, and 2) realistic error estimates for each network control station.

Integration: Accurate spatial positioning of scientific data from the cultural, biological and physical programs is necessary for facilitating change detection methods. Historical data must be adjusted to reliable coordinates before integration into the database and before these resource assessments can be made. Often, past surveys that relate to current monitoring efforts have been referenced to local datums. These sites also require accurate positional and elevational data before the data can be entered into the GIS database for examination and change detection.

MO's and IN's ADDRESSED: Goals 6, 7, 8, 11, and 12, MO's 6.4, 7.3, 8.1, 8.2, 8.3, 8.4, 8.5, 9.3, 11.1, 12.2, 12.3, and 12.9.

Consequences of FY05 Funding Recommendations: Funding will allow for more accurate change detection using GIS tools and utilize the expertise of the NGS and cooperators to create more accurate error estimates for all spatial data sets. Additional funds will be preserved by attaining accurate positions and elevations of spatial data prior to integration into GIS database.

Status/Schedule: The CRE geodetic control network schedule has been modified to reflect changes resulting from the development of the long-term monitoring reaches of the biological, cultural, and physical resource programs. Efforts have been concentrated to establish, verify and validate the coordinates of the control stations utilized in these monitoring studies. Additional efforts have added 9 stations to the primary rim control network and 36 secondary control stations extending the line-of-site network from Glen Canyon Dam to Bright Angel Creek. These efforts both increase accuracy of the entire network and minimize errors inherent with longer baselines (distances from known to unknown positions). Future survey operations will increase accuracy of CRE control points by expanding the river corridor network. These GPS data sets will be combined with conventional traverse measurements to evaluate the effects of varying geoid undulations and to give realistic error estimates to all network control stations.

Project Goals and Objectives: The objective of this project is to develop a high-precision control network throughout the CRE. Control monuments will be established at consistent intervals throughout the CRE and at locations required for accurate positions and elevations of past, current, and future data sets. The goal of this project is the expansion of the control network into the necessary areas prior to spatial data collection required by the research activities. By having stable control monuments and accurate coordinates completed before spatial data acquisition begins, post-processing methods are reduced, and both human resources and money are conserved.

Expected Products: The products of the CRE control network project will be:

- A network of survey control points established in specific research areas and throughout the CRE, referenced to the primary control network established by the Grand Canyon Monitoring and Research Center and the National Geodetic Survey.
- Coordinates and realistic positional and height accuracy estimates for all network control stations will be available to the National Park Service, the GCMRC, and all cooperating agencies.
- Index maps showing the location of the network control stations.
- Creation of a Photo-identifiable Fixed Point Database for georeferencing of past datasets and accuracy evaluation of remotely sensed data.
- GIS layers with control station information.

Timeline for Geodetic Control Network

2001	2002	2003	2004	2005
Primary Network Established, LSSF reaches surveyed	LTM reaches surveyed, Line-of-site network established to Bright Angel Creek	Densification of primary network, Accuracy assessment of previous control network	Georeferencing of historical datasets upstream of Bright Angel Creek	Primary, secondary and tertiary network adjustment, NSRS inclusion data. Georeferencing of historical datasets throughout CRE

E. INFORMATION AND OUTREACH PROGRAM

Project E.1. Information Office

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor	N/A	N/A	N/A	65,000	0
Logistics (All)	N/A	N/A	N/A	0	0
Operations	N/A	N/A	N/A	10,000	0
GCMRC Salaries	N/A	N/A	N/A	0	0[1]
Project Total	N/A	N/A	N/A	75,000	0
% Total Outsourced*	N/A	N/A	N/A	85%	0

*Includes 50% of logistical costs
[1]Program manager salary covered under Program Planning and Management

Principal Investigators: Mike Liszewski, U.S. Geological Survey (BRD)

Statement of Problem: The GCMRC is a science organization within the GCDAMP that produces data, analysis, and reports relating to the effects of the operations of Glen Canyon dam on the Colorado River Ecosystem (CRE). The GCMRC has extensive historical data and information collected over many years relating to the condition of resources in the Colorado River ecosystem. New data and information are being collected daily. Some of this data resides on mature DBMS systems but much of it remains on floppy disks or hard disks on personnel computers using PC-type spreadsheets and database formats. Some of these products go unnoticed and many are underutilized because they are not centrally located and cataloged, or are difficult to obtain.

The two distribution mechanisms used by GCMRC are its library and Website. For the most part, the library is fully functional with web accessible catalogs of all library content. However, limited library content is available on-line. To help remedy this, the library has embarked upon a project to digitize legacy hardcopy library content to facilitate distribution over the Internet.

Some digital data is currently available on the GCMRC FTP site. This data is often non-descript and difficult to navigate. It is the intent of the Information Office to integrate this data into the GCMRC website with complete data descriptions and navigation tools. Data from other sources will be integrated into the GCMRC website as it becomes available.

Summary Project Description: The information office consolidates, catalogs, and digitizes these products for rapid and timely distribution to our stakeholders, cooperators, and the public through centrally located distribution mechanisms such as our library and website. Web development and maintenance services will be procured through contract.

These activities require a robust and efficient computing infrastructure. Therefore, system administration activities reside in the information office to facilitate its computing needs as well as general GCMRC office automation and data processing and analysis requirements.

The Information Office also coordinates GCMRC review activities.

MO's and IN's ADDRESSED: The GCMRC information office is intended to provide a centrally located distribution point for data and information relating to all GCMRC science activities.

Consequences of FY06 Funding Recommendations: The currently proposed budget for FY 2006 provides for the continued development and integration of new products into the centrally located distribution points (i.e., library and website). Reduced funding will impair our ability to fully develop the infrastructure necessary to implement the distribution technologies and integrate new data and information as they become available.

Status/Schedule: The GCMRC information office was formally established in FY 2004. Program development is expected to continue through 2005 at which point the program will enter into a maintenance mode that will primarily involve minor system tweaking and the integration of new data and information as it becomes available. It is anticipated that new development cycles will need to commence on 1 to 3 year intervals depending upon the changing needs of GCMRC science activities, user needs, and advances in technology.

Expected Products/Deliverables: The primary products of the information office are the library and website from which data, analysis, reports, and scientific publications can be obtained. These products include tabular and spatial data; reports, peer reviewed scientific publications, fact sheets, presentations, and posters; slides, videos, and photographs (including aerial photos); maps, strategic and annual work plans, program and project descriptions, requests for proposals, personnel listings and events. Releasable electronic data and information will be freely available to stakeholders, cooperators, and the public through our website. Hardcopy data

and information will be available through our library. Legacy hardcopy data will be digitized for distribution from our website on a time available basis.

Specific products include the following:

- Comprehensive and fully functional website with access to all non-sensitive digital data and information relating to the effects of dam operations on the CRE. Non-digital data and information will be cataloged electronically with instructions on how to obtain it.
- Comprehensive and fully functional library containing all hard copy and digital media containing data and information relating to the effects of dam operations on the CRE cataloged and accessible. Sensitive and non-releasable data and information will be archived and secured separately from releasable data and information.
- Peer review of reports, scientific publications, fact sheets, and presentations.
- Fully functional and integrated computing environment.

Timeline for project implementation and maintenance:

	2004	2005	2006
Project development – build web and library infrastructure	January through December	January through December	
Project maintenance – integration of new data and information	Annual, January through December	Annual, January through December	Annual, January through December

Project E.2. Systems Administration

FUNDING HISTORY	**Fiscal year**				
	2002	**2003**	**2004**	**2005**	**2006**
Outside GCMRC Science/Labor	**0**	**0**	**17,000**	**17,000**	**0***
Logistics Field Support	**0**	**0**	**0**	**0**	**0**
Project Related Travel/Training	**—**	**—**	**—**	**—**	**5,000**
Operations/Supplies	**111,000**	**166,000**	**166,000**	**166,000**	**165,000**
GCMRC Salaries	**57,000**	**84,200**	**80,000**	**80,000**	**129,600****
Project Subtotal	**—**	**—**	**—**	**—**	**299,600**
DOI Customer Burden (15%)	**—**	**—**	**—**	**—**	**44,940**
Project Total	**168,000**	**250,200**	**263,000***	**263,000***	**344,540**
% Total Outsourced	**0%**	**0%**	**6%**	**6%**	**0%**

*Outsourced science/labor reduced to $0 due to conversion of two student contractors into one full-time computer technician.
**GCMRC salaries increase results from more accurate reporting of the system administration position ($86,600 as opposed to $80,000) and adding a full-time computer technician from footnote 2 ($43,000).

Principal Investigators: Dale Blank, U.S. Geological Survey (BRD)

Statement of Problem: The GCMRC computing environment is a complex system of servers, workstations, laptops, printers, plotters, disk arrays, routers, hubs, switches, tape backups, copy and Fax machines, and audio-visual and telecommunications equipment. In addition, over 50 software applications are utilized by scientists and support personnel in carrying out the collective mission of the GCMRC. These devices must work together in a reliable, seamless, and secure manner in order to facilitate the mission of GCMRC.

Summary Project Description: Systems administration supports the collective mission of GCMRC by providing a secure and standardized computing environment for scientists, managers, administrators, and support staff. Computer hardware is largely a combination of state-of-the-art PC (Intel) processors running the Microsoft Windows operating system. Each workstation has a core suite of software applications that include mainstream off-the-shelf integrated office products such as a word processor, spreadsheet, graphics, database, Internet browser, etc. Additional software needed for specialized scientific data processing is also available. To the extent possible, hardware and software is standardized throughout the GCMRC. Standardization facilitates the inter-office exchange of information and reduces the administrative effort needed for hardware and software support to a sustainable level.

MO's and IN's ADDRESSED: Systems administration supports all GCMRC science and administrative programs.

Consequences of FY06 Funding Recommendations: The currently proposed budget for FY06 will maintain the current level of computer support. Reduced funding will result in the possible loss of scientific data due to backup equipment failure and lack of storage capacity. Potential loss of productive work hours for scientists and management due to breakdowns in equipment. Loss of software licensing and upgrades, impacting scientific programs. Reduced updates and development on internal and external web sites.

Status/Schedule: FY01 – Initiated in its current design as a standardization and support effort for the entire GCMRC. FY 2004-06, were identified to be years in which increased disk storage, increased web presence and public accessibility to information are priorities.

Expected Products/Deliverables: Specific products of GCMRC systems administration are:

- Desktop and servers - GCMRC's computing environment is based upon the PC platform, Microsoft Windows operating system, and Microsoft Office, office automation software. Systems maintenance is performed using a combination of warranty service, service contracts, and in-house service as needed to facilitate quick turnaround, minimize downtime, and reduce costs.
- Network environment- Computer interconnectivity is provided using TCP/IP network communication protocol running on a 1000baseT and 100baseT network media. Network traffic is arbitrated by 4 3COM switches and hubs operating at 100 Mbps and 1 Gbps.
- Internet connectivity– The GCMRC computer network is linked to the Internet through the Flagstaff Field Center GEOnet-3 router that provides a DS-3 (45 Mbps) virtual circuit to Menlo Park where it joins the U.S. Geological Survey's GEOnet network. Also located in Menlo Park is a network portal to the Internet operated by the U.S. Geological Survey and NASA through a peering partnership. GEOnet provides a secure Survey-wide networking environment that interconnects headquarter region, district, and field offices located throughout the United Sates.
- Intranet website– GCMRC's intranet offers a secure centralized medium for information exchange among GCMRC employees. Among things to be internally shared via the intranet are: standard operating procedures, personnel availability and contact info, vehicle and equipment loans, and an IT support system. The GCMRC intranet is served from a Windows 2000 Server utilizing ASP.
- Computer security – Network security is provided by firewalls, routers, system update server (SUS), systems management server (SMS) and antivirus (AV). Firewalls and routers are configured and maintained to restrict outside access to authorized systems. Operating systems (OS) are updated to minimize vulnerabilities using SUS that automates a central delivery system for patch management. AV updates are downloaded from the web as released and pushed to all systems the same night.
- System back-up and disaster recovery – System back-up and disaster recovery is accomplished using dual LTO tape drives in a 30 slot carriage with a capacity of 3 Tbytes. Tapes are stored locally in a fire vault and archival tapes are stored off-site. Server disks are configured to run either a raid-5 array or mirrored for redundancy.
- Web and FTP Services – The GCMRC web site and FTP site serve to make the mission and findings of GCMRC accessible to the public. The sites offer our updated work plan, descriptions of our program areas, and various interactive stores of data including our Internet Map Server and our online library.
- Online discussion forums – GCMRC hosts on-line discussions forums for the AMWG, GCMRC, and the U.S. Geological Survey LiDAR discussion group. These forums provide a widely accessible medium for informal discussions and announcements relating to the respective topics.
- Troubleshooting and maintenance – helpdesk support is provided as requested/required. Requests are received via the web, email and telephone. Support is tracked in a searchable database with solutions to facilitate prioritization and resolution.

- Data storage – Over 7 Tbytes of on-line disk storage is provided by multiple servers with SCSI disk arrays. Server disk arrays are hot swappable to minimize downtime. GCMRC also utilizes Networked Attached Storage (NAS) devices. These devices are IDE drives connected to a SCSI backplane. NAS units are used to provide bulk storage capacity at less expense.

Project E.3. Library

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor	0	15,249	0	17,000[1]	23,175[2]
Logistics Field Support	0	0	0	0	0
Project Related Travel/Training	—	—	—	—	4,000
Operations/Supplies	18,000	29,000	39,000	39,000	29,250
GCMRC Salaries	47,500	32,800	40,000	43,000	57,600[3]
Project Subtotal	—	—	—	—	114,025
DOI Customer Burden (15%)	—	—	—	—	17,104
Project Total	65,500	77,049	79,000	99,000	131,129
% Total Outsourced	0%	20%	0%	17%	20%

[1]Student contractor funding for 2004 funded in 2003.
[2]This figure assumes an increase in pay rate for a student contractor with a bachelor's degree as well as additional costs of hiring through a university and other services.
[3]This figure reflects the total salary of Librarian. Previously, a portion of this salary was covered under the independent review line-item.

Principal Investigators: Stephanie Wyse – GCMRC and Esther Quinn - Contractor

Statement of Problem: The scope and purpose of the library is to collect, archive and deliver materials that assist GCMRC in its efforts to administer long-term monitoring and research. Many of these materials are archival, meaning only one copy exists, and are at risk of loss or damage. The library program also coordinates GCMRC's peer review process to ensure the high quality of the scientific information it produces.

Summary Project Description: Library operations facilitate monitoring and research by providing a centralized repository for hard copy information such as books, reports, maps, photography, and videos. The library has undertaken a project to convert all materials in the library and make them accessible on the GCMRC website. Having materials available through

the website will allow multiple users to access data concurrently from remote locations as well as protect one of a kind items from damage or loss. This project commenced in 2003 and will be completed in 2008. Independent scientific peer review at all levels of GCMRC scientific activities -- proposals, ongoing programs, publications, and other products -- provides a mechanism for ensuring the quality, credibility, and objectivity of GCMRC's scientific activities.

MO's and RIN's ADDRESSED: The library provides support to the GCMRC science programs and the adaptive management program and addresses all MO's and RIN's.

Consequences of FY06 Funding Recommendation: The currently proposed budget for FY06 will maintain the current level of library support. In addition, the library scanning project will proceed on schedule. Additional funding during 2006 would allow the library scanning project to proceed ahead of schedule and increase the number of digital products available on the website in 2006.

Status/Schedule: FY2006 is year 4 of the six year scanning project. All other library activities are ongoing.

Expected Products/Deliverables: Specific products of the library include:

- On-line library catalog which provides access to more than 8000 publications.
- Catalog records of new materials.
- Monthly update of new reports received in the library.
- Review process for proposals and reports which includes a monthly report of the status of deliverables as it relates to the review process.
- Assistance to cooperators, stakeholders, media contacts and the public by providing access to reports, aerial photos, maps, slides and photos in hardcopy and digital form.
- Research in locating contemporary and legacy materials.
- A research facility for researchers, GMCRC employees, cooperators and the public.
- Access to 17,652 aerial photographs, 9000 digital aerial images, 8000 hardcopy reports, 8000 photos and slides, and 700 videos in broadcast and VHS format. In additional, once the library scanning project is complete, this information will be available in digital format from the library via digital media such as DVD and on-line via the World Wide Web.

TIME LINE FOR PRODUCT COMPLETION FOR LIBRARY SCANNING PROJECT FY03-07

	2003	2004	2005	2006	2007
Work plan completed, contract staff hired and equipment purchased	End of FY2003				
Project Completion Schedule:					
Aerial Images			200 film frames scanned	400 film frames scanned	400 film frames scanned
Texts		300 texts scanned	300 texts scanned	200 texts scanned	200 texts scanned
Videos		500 broadcast videos converted to digital format	21 broadcast videos converted to digital format	121 VHS videos converted to digital format	
Slides		8000 slides scanned at high and low resolution			
Photos		700 photos scanned at high and low resolution			
Flightline Maps					60 Arc Info Coverages

CHAPTER 3

ADMINISTRATION AND TECHNICAL SUPPORT SERVICES

INTRODUCTION

This chapter provides descriptions and budget information on GCMRC administration and technical support services. GCMRC administration includes sections on administrative operations, program planning and management, AMWG/TWG participation, and the independent review process. Technical support services include geographic information systems, systems administration, library operations, database management, survey operations, and logistics support. At the end of this chapter is a schedule for implementing the FY 2006 monitoring and research annual plan.

GCMRC ADMINISTRATION

The GCMRC is currently administered by a Chief and five Program Managers: Physical Science, Modeling and DASA Program, Biological Sciences, Socio-cultural, Logistics and the Information Program. As mentioned above, a Biology Program Manager will be hired in the near future; at this time the position is filled with an Acting Biology Program Manager. The Program Managers provide Center support as Deputies to the Chief and oversee the individual resource areas and an extensive program of data analysis and management. GIS and information transfer, surveying, and evaluation of remote sensing technologies support program integration and evaluation of the effects of dam operations on the CRE.

In addition to their program management responsibilities, the program managers are also expected to remain subject area experts in their respective fields on the Colorado River ecosystem. It is important that GCMRC program managers and scientific staff maintain this expertise so they can provide high quality technical assistance in the form of expert analysis, opinion, and advice to the Chief, TWG and the AMWG as requested. This will include, but is not limited to, the State of the Canyon Resources (SCORE) Report, evaluation of the Beach/Habitat-Building-Flow (BHBF) resource criteria, and preparing syntheses of current knowledge and other such activities that may be requested. The Socio-cultural Program

Manager also functions as the Native American Coordinator. The program managers supervise additional technical and support staff, and act as project lead with their cooperators.

The Information Program has personnel with specific responsibility for systems administration, and library activities. A major focus of the new program will be outreach to our stakeholders emphasizing knowledge of, and access to data and tools available as a result of GCMRC monitoring and research activities. Under this organization, surveying activities are now merged with the Logistics Program in an effort to align them more closely with the monitoring and research activities they support. For example, the surveying department is staffed by two full-time surveyors and a staff assistant who provide GCMRC and other researchers with high quality, cost-effective, and timely support in the areas of terrestrial and bathymetric surveying. Having in-house capability ensures familiarity with the challenges of surveying in the canyon and promotes reproducible, quality data critical to sound monitoring and research programs. These personnel assure critical support to GCMRC monitoring and research program.

The GCMRC will continue to conduct logistics for its programs in FY 2006, with direct coordination with appropriate NPS offices. This approach has proven to be cost-effective. In addition to cost savings, by running the logistics program in-house, GCMRC is able to ensure compliance with all NPS directives, consolidate and coordinate river trips, and create a level playing field so all researchers have an equal chance at competing for proposals and successfully implementing their projects. All river trip logistics and permitting, helicopter support, rescue, etc., is overseen by the logistics coordinator in cooperation with the NPS. GCMRC expects to initiate between 30 and 35 river trips in FY 2006.

F. ADMINISTRATION AND MANAGEMENT

F.1. Administrative Operations

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Admin costs	—	—	395,000	400,000	15,000
Logistics Field Support	—	—	—	—	0
Project Related Travel/Training	—	—	—	—	36,325
Operations/Supplies	—	340,500	154,000	160,000	274,994
GCMRC Salaries	—	243,500	71,000	78,000	262,000
Subtotal	—	—	—	—	588,319
DOI Customer Burden (15%)	—	—	—	—	88,248
Project Total	—	584,000	620,000	638,000	676,567
% Total Outsourced	0%	0%	64%	63%	2%

These costs are for salary and other operating expenses in support of administrative operations and management of GCMRC. Included is salary of the Chief and administrative staff, space and facilities, non-project related travel and training, vehicles, office supplies and equipment and maintenance. Also included are costs for USGS local network, Flagstaff Science Center support, and USGS regional services including contracting and personnel.

F.2. Program Planning and Management

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor	—	—	—	—	0
Logistics Field Support	—	—	—	—	0
Project Related Travel/Training	—	—	—	—	15,000
Operations/Supplies	—	226,000	20,000	22,000	0
GCMRC Salaries	—	243,000	254,000	260,000	465,000
Subtotal	—	—	—	—	480,000
DOI Customer Burden (15%)	—	—	—	—	72,000
Project Total		584,000	274,000	282,000	552,000
% Total Outsourced	0%	0%	0%	0%	0%

In FY2006, in an effort to simplify distribution of program planning and management salaries and travel, the Program Manager salaries were assigned to this category exclusively. Travel expenses in support of the program, but separate from TWG and AMWG participation are also included. These costs are for the five Program Managers: Physical Science, Modeling and DASA, Biological Sciences, Socio-cultural Resources, Information Office and the Logistics Program.

F.3. AMWG/TWG Participation

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor	—	—	—	—	0
Logistics Field Support	—	—	—	—	0
Project Related Travel/Training	—	—	—	—	15,000
Operations/Supplies	—	12,000	12,000	12,350	0
GCMRC Salaries	—	26,500	33,000	34,000	0
Subtotal	—	—	—	—	15,000
DOI Customer Burden (15%)	—	—	—	—	2,250
Project Total	—	38,500	45,000	46,350	17,250
% Total Outsourced	0%	0%	0%	0%	0%

Included in this category are the travel expenses related to attending and participating in TWG and AMWG meetings. Project related travel expenses are accounted for by projects, and administrative travel (e.g. safety training) are planned under the Administrative Operations budget.

F.4. Independent Review Panels

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor	—	89,000	200,000	240,000	175,000
Logistics Field Support	—	—	—	—	0
Project Related Travel/Training	—	—	—	—	0
Operations/Supplies	—	—	—	—	0
GCMRC Salaries	—	10,000	22,000	32,000	0
Subtotal	—	—	—	—	175,000
DOI Customer Burden (15%)	—	—	—	—	26,250
Project Total	—	99,000	222,000	272,000	201,250
% Total Outsourced	0%	90%	90%	90%	100%

Independent external review is at the heart of GCMRC's approach to program management and implementation. Together with the competitive process, independent external peer-review ensures the quality and objectivity of GCMRC's programs. Independent review panels are utilized to evaluate GCMRC's plans and activities. All proposals, reports, programs, etc., are subject to independent peer review according to GCMRC's peer-review protocols. Managing GCMRC's peer-review process requires 3 to 6 person-months and is the responsibility of the Librarian/Review Coordinator. The Review Coordinator reports to the Information Program Manager.

Peer Review

All of GCMRC's scientific activities undergo an independent, external peer-review. This is true for all proposals, whether unsolicited, solicited, or an in-house proposal. Similarly, all draft reports received by GCMRC undergo independent, external peer-review. The peer-review protocols developed by GCMRC meet or exceed the standards articulated by the Secretary of the Interior for the Department of the Interior.

Peer-review for proposals received by GCMRC in response to an RFP is conducted through a panel process, while peer-review for unsolicited and in-house proposals, as well as project reports is conducted through the mail. In all cases, the peer-reviewers are offered anonymity and the individual and panel reviews, where applicable, are provided to the PIs along with comments from GCMRC. In addition, GCMRC conducts protocol evaluation panels (PEPs) to review and assess GCMRC's projects and methodologies. To date, PEPs have been held for remote sensing, physical, survey control, terrestrial and aquatic, cultural resources and the water quality program. Recommendations from the various PEPs are described in Chapter 1 of this plan.

The GCMRC review process is handled by a report review coordinator to ensure that the peer-review process is conducted one-step removed from the GCMRC program managers to guard against any conflicts of interest, real or perceived. Strict conflict-of-interest guidelines are adhered to. GCMRC annually recruits new individuals to join the ranks of its peer-reviewers and maintains a database of almost 500 potential reviewers, organized by area of expertise. GCMRC peer-reviewers come from academia, Federal, State and Tribal government, non-governmental organizations, and the private sectors. Reviewers are selected on the basis of their record of scientific accomplishment and expertise.

Science Advisors

The GCMRC works with a group of Science Advisors (SAs) as one of its independent review panels. The SAs are advisory and not a decision-making body. It is an interdisciplinary group composed of scientists who are qualified, based on their record of publication in the peer-reviewed literature, or other demonstrable scientific achievements. An executive Director provides leadership to the SAs and serves as the liaison officer to the AMWG and the GCMRC.

The SAs together and individually will be expected in FY 2006, among other things, to review and comment to the AMWG and GCMRC on: (1) GCMRC's annual work plan and budget proposal, (2) GCMRC's long-term monitoring and research plan, (3) the results of GCMRC's completed monitoring and research activities, (4) the results of any synthesis and assessment activities initiated by the GCMRC, and (5) any other activities (i.e., developing a monitoring plan, enhancing opportunities for integrated science, and other program specific scientific advice) it is asked to address by the GCMRC Chief or the AMWG.

TASK GROUPS

Task groups have been established in areas where GCMRC seeks on-going dialogue and guidance for specific issues. Two task groups are described below; however, other task groups can be formed as needs arise.

A Cultural Resources Task Group operates to facilitate the incorporation of cultural concerns within all GCMRC program areas to assist the GCMRC in the development of a more integrated program that incorporates Native American perspectives in project development and work plans. The Task Group consists of the GCMRC Socio-cultural Resources Program Manager, Reclamation's Regional Archaeologist, NPS managers, Western Area Power Administration's Archaeologist, and Tribal representatives. In addition, a tribal task group functions to obtain guidance from tribal representatives in program development, and program and project implementation.

A Biological Opinion Task Group operates to ensure appropriate coordination between GCMRC and the monitoring and research needs of the Bureau and USFWS under various biological opinions. The Task Group consists of the GCMRC Biological Resources Program Manager and appropriate representatives of Reclamation, FWS, AGFD, Tribal governments, and other AMWG and TWG members. All proposed activities are reviewed by the TWG.

GCMRC BUDGET

In FY 2003 the USGS began full-cost recovery accounting and instituted a DOI customer rate of 15% against all DOI agency reimbursable funding. The DOI customer rate was established by the USGS Bureau Headquarters and determined to be significantly lower than the "full" burden rate that varies annually and includes facilities and the Cost Center and the Bureau burdens. In addition to the above rates, a special "pass through" rate of 6% was also instated. As a transitional aid to GCMRC, which had received under a previous administration the guarantee that USGS would not charge the power revenue funds any burden, the Bureau allowed the entire GCMRC power revenue budget to be charged only the 6% special rate (3% was retained by the Cost Center and 3% by Headquarters).

In FY2004, USGS Headquarters approved the special rate of 6% for only a portion of GCMRC's power revenue funding. This rate was applied to approximately $1 million dollars of funding that went directly to GCMRC cooperators. The balance of power revenue funds were charged the full DOI customer rate of 15%. As a part of the full cost recovery policy, the USGS established a process referred to as "cost share" as a means of handling a limited electronic financial system.

Cost Share is the funding that "covers" the balance of the full burden rate minus the DOI customer rate. In most cases, reimbursable funding from non-DOI agencies is charged the full burden rate. In FY 2004, the full burden rate for GCMRC was approximately 30%. The difference between the full rate of 30% and the DOI Customer rate of 15% equals 15% (all percentages are approximate). In FY 2004 the cost share funding requirement for all DOI agency reimbursable dollars received by GCMRC equaled almost $1 million. USGS policy requires cost share funding be from appropriated dollars only, and those funds are also charged the Cost Center burden rate. In essence, the $1 million dollar appropriation provided by USGS to GCMRC in FY 2004 had the effect of not adding funding, but merely filling the holes created by the cost share policy.

In FY 2005 and FY 2006 the USGS appropriation expected for GCMRC (also $1 million), should not be added to the funding table (refer to E-188 and 189). Per the full cost accounting policy and the requirement that cost share dollars be appropriated dollars only, the effect of these appropriations is entirely transparent and does not add funding to the AMP.

In the FY2006 budget proposal and spreadsheet (see attached) for GCMRC, the costs are not necessarily correct for FY 2005. This is because of a discrepancy in funding amounts and application of the USGS $1 million appropriation discovered by GCMRC and the BOR during a January, 2005 budget meeting held in Salt Lake City. The expenses identified will need to be reworked to account for the discrepancy in funding and cost share expenses as well as the 15% DOI customer burden.

The total FY 2005 and FY 2006 budgets for the AMP are $10,564,000 and $10,688,425 respectively. These totals include $8,572,000 in FY 2005 and $8,786,300 in FY 2006 from AMP Power Revenues; and $210,000 and $215,250, respectively, from the Bureau of Reclamation Water Quality fund for both years.

REFERENCES CITED
(Revision in progress)

Arizona Game and Fish Department. 2001. Salmonid population size in the Colorado River, Grand Canyon, Arizona. Fishery Fact Sheet, Arizona Game and Fish Department, Phoenix, AZ.

Austin, D., I. Bullets, B. Drye. 2000. Educational Outreach Program for Southern Paiute Cultural Resources along the Colorado River in the Grand Canyon. Submitted to the Grand Canyon Monitoring and Research Center.

Balsom, J.R. and S. Larralde (editors). 1996. Mitigation and monitoring of cultural resources in response to the experimental habitat building flow in Glen and Grand Canyons, Spring 1996. USDI Bureau of Reclamation, Upper Colorado Region, Salt Lake City.

Begay, R. M. 2001. 2000 Navajo Nation River Trip. Submitted to Bureau of Reclamation.

Behan. 2000.

Bordon, F.Y. 1976. User carrying capacity for river-running the Colorado River in the Grand Canyon, USDOI, National Park Service, Colorado River Research Program, Technical Report No. 9.

Brandford et al. 2001.

Breedlove M. 2003

Brian, N.J. and J.R. Thomas, 1984, 1983. Colorado River Sand Bar Campsite Inventory. Division of Resources Management, National Park Service, Grand Canyon National Park, AZ.

Brown and Hahn-O'Neil. 1987.

Bullets, I. 2003. Southern Paiute Consortium Colorado River Corridor Resource Evaluation Program Annual Report of activities. Report prepared for the U.S. Bureau of Reclamation, Upper Colorado Region, Salt Lake City.

Coggins, L. and M. Yard. 2003. Mechanical removal of non-native fishes in the Colorado River in Grand Canyon: Update of winter 2003 operations and findings. Report to GCMRC.

Coggins, L. and C. Walters. 2001. Trends in the recruitment and abundance of humpback chub (*Gila cypha*) in the Little Colorado River. American Fisheries Society Meeting Abstract.

Culver, D.A., B.L. Kerans, M. Liermann, and G.R. Wilde. 2000. Final Report of the Lees Ferry Rainbow Trout Monitoring Peer Review Panel. Submitted to Grand Canyon Monitoring and Research Center, Flagstaff, AZ 86001.

Davis, P.A. 2003. Remote Sensing Evaluation Report.

Davis, W. E. 2003. Stranding of rainbow trout during experimental fluctuating releases from Glen Canyon Dam on the Colorado River. EcoPlan Associates, Inc., Report 02-606. Cooperative agreement number 01WRCN0036. Submitted to Grand Canyon Monitoring and Research.

Department of the Interior. 1995. Final EIS.

Doelle, W. (editor). 2000. Final Report: Cultural Resource Program Assessment. Protocol Evaluation Panel submitted to Grand Canyon Monitoring and Research Center, Flagstaff, AZ.

Dongoske, K.E. 2001. Annual Report on the Hopi Tribe's Involvement in the Glen Canyon Dam Adaptive Management Program and the Programmatic Agreement Regarding Historic Properties. Submitted to the Bureau of Reclamation.

Douglas, M.E. and P.C. Marsh. 1996. Population estimates/population movements of Gila cypha, and endangered Cyprinid fish in the Grand Canyon region of Arizona. Copeia 1:15-28.

Drye, B., I. Bulletts, A. Phillips III, T. Snow, G. Stanfield. 2001. 200a southern Paiute Consortium Colorado River Corridor Resource Evaluation Program: Annual Report of Activities. Submitted to Bureau of Reclamation.

Erquhart et al. 2000

Fairley, H. 2003. Changing River: Rime, culture and the transformation of landscape in the Grand Canyon. SRI Technical Series No. 79. SRI Press, Tucson.

Fairley, H. 2004

Gorman O.T., R.G. Bramblett. 1998. Monitoring and studies of native fishes of the Colorado River ecosystem in Grand Canyon, Arizona. US Fish and Wildlife Service submitted to Grand Canyon Monitoring and Research Center, Flagstaff, AZ.

Hazel J., M. Kaplinski, R. Parnell, M. Manone. 2001. Monitoring the Effects of the Spring 2001 Habitat maintenance Flow on Colorado River Ecosystem Sand Bars. Northern Arizona University, Department of Geology Sand Bar Studies Fact Sheet.

Hazel J., M. Kaplinski, R. Parnell, M. Manone. 2001. Monitoring the Effects of the Spring 2002 Habitat maintenance Flow on Colorado River Ecosystem Sand Bars. Northern Arizona University, Department of Geology Sand Bar Studies Fact Sheet.

Hazel J., M. Kaplinski, R. Parnell, M. Manone, Alan Dale. 1999. Topographic and Bathymetric Changes at Thirty-three Long-Term Study Sites. American Geophysical Union Monograph #110, pages 161-184.

Hazel J., M. Kaplinski, R. Parnell, M. Manone. 2001. Monitoring the Effects of the Spring 2000 Habitat maintenance Flow on Colorado River Ecosystem Sand Bars. Northern Arizona University, Department of Geology Sand Bar Studies Fact Sheet.

Hereford, R. 1993. Description of Map Units and Discussion to accompany Map showing Surficial Geology and Geomorphology of the Palisades Creek Archeologic Area, Grand Canyon National Park, Arizona. U.S. Geological Survey (U.S. Geological Survey Open-File Report 93-553). Flagstaff, AZ.

Hereford, R., H. C. Fairley, K. S. Thompson and J. R. Balsom. 1993. Surficial Geology, Geomorphology and Erosion of Archeologic Sites along the Colorado River, Eastern Grand Canyon, Grand Canyon National Park, Arizona. Grand Canyon National Park in cooperation with the U.S. Bureau of Reclamation, Glen Canyon Environmental Studies (U.S. Geological Survey Open-File Report 93-517). Flagstaff, AZ.

Hereford, R., K. S. Thompson, K. J. Burke and H. C. Fairley. 1995. Late Holocene Debris Fans and Alluvial Chronology of the Colorado River, Eastern Grand Canyon, AZ. U.S. Geological Survey (U.S. Geological Survey Open-File Report 95-57). Flagstaff, AZ.

Hereford, R., K. J. Burke and K. S. Thompson. 1996. Description of Map Units and Discussion to Accompany Map Showing Quarternary Geology and Geomorphology of the Nankoweap Rapids area, Marble Canyon, Arizona. U.S. Geological Survey (U.S. Geological Survey Open-File Report 96-502). Flagstaff, AZ.

Hjerpe, and Kim. 2001.

Jalbert L. 2003. Implications of Low Summer Steady Flows on Whitewater Boating Safety and other Recreational Attributes. Paper presented at the 2003 GCMRC Science Symposium, Tucson.

Jonas, L. and W. Stewart. 2002. An overview of various impacts to Grand Canyon River Experiences with at focus on intergroup encounters, flow levels, and the 2000 Low Summer Steady Flow Experiment. Report prepared in fulfillment of Contract #00PG400250, SWCA Environmental Consultants, Flagstaff.

Kaplinski, M. et al. 1994.

Kaplinski, M., J. Hazel, R. Parnell, M. Manone, M. Gonzales. 2003. Long-term monitoring of fine-sediment storage throughout the Colorado River ecosystem. Annual progress report.

Kaplinski, M., J. Behan, J. E. Hazel, M. Manone, and R. Parnell. 2003. Evaluation of campsite studies in the Colorado River Ecosystem: Analysis and recommendations for long-term monitoring. Final Report in fulfillment of CA-00PG-400255-0001.

Kaplinski, M., J. Hazel, R. Parnell, M. Manone, M. Gonzales. 2000. Evaluation of Hydrographic Survey Techniques Used for Channel Mapping by the GCMRC in the Colorado River Ecosystem, Grand Canyon, AZ. Unpublished report.

Kaplinski, M., J.E. Hazel, Jr., and S.S. Beus. 1995. Monitoring the effects of interim flows from Glen Canyon Dam on sand bars in the Colorado River Corridor, Grand Canyon National Park, Arizona Final Report to Glen Canyon Environmental Studies, 62 pp., N. Ariz. Univ., Flagstaff, AZ.

Kearsley, L. H. 1994. Effects of Glen Canyon Dam on Colorado River sand deposits used as campsites in Grand Canyon National Park, USA. Regulated Rivers: Research and Management, v9, 137-149.

Kearsley, M.J.C. 2003.

Kearsley, M. J. C., N. Cobb, H. Yard, D. Lightfoot, S. Brantley,G. Carpenter, J. Frey. 2002. Inventory and monitoring of terrestrial riparian resources in the Colorado River corridor of Grand Canyon: An integrative approach. 2002 Annual Report. Cooperative agreement number 01WRAG0044 and 01WRAG0034. Submitted to USGS/GCMRC.

Kearsley, L. H., R. D. Quartaroli and M. J. C. Kearsley. 1999. Changes in the number and size of campsites as determined by inventory and measurement in The Controlled Flood in Grand Canyon. Geophysical Monograph 110, American Geophysical Union.

Kearsley, L. H. 1995. Monitoring the effects of interim flows on campsite size along the Colorado River in Grand Canyon National Park (final report). Grand Canyon National Park Division of Resource Management, National Park Service. In cooperation with USDOI Bureau of Reclamation, Glen Canyon Environmental Studies, Cooperative Agreement CA8022-8-0002.

Kearsley, L. H., R. D. Quartaroli and M. J. C. Kearsley. 1999. Changes in the number and size of campsites as determined by inventory and measurement in The Controlled Flood in Grand Canyon. Geophysical Monograph 110, American Geophysical Union.

Kearsley, M.J.C, and T.J. Ayers. 2001. Review assessment and recommendations regarding terrestrial riparian vegetation monitoring in the Colorado River corridor of Grand Canyon. Submitted to Grand Canyon Monitoring and Research Center, Flagstaff, AZ 86001.

Kearsley, L. H. and K. Warren. 1993. River campsites in Grand Canyon National Park: Inventory and effects of discharge on campsite size and availability (final report). Grand Canyon National Park, Division of Resource Management, National Park Service.

Kunde, J.L., L. Leap, N. B. Andrews. 2001. Draft Annual report, FY 2001. River Corridor Monitoring Project No. 70, Grand Canyon National Park and Northern Arizona University. Cooperative Agreement No. CA 8210-97-002.

Leap, L. M., J. L. Dierker, and N. Andrews. 2003. Archaeological site monitoring and management activities along the Colorado River in Grand Canyon National Park. Grand Canyon National Park River Corridor Monitoring Report No. 89. Submitted to Bureau of Reclamation, Upper Colorado Region, Salt Lake City.

Leap, L. M., J.L. Kunde, D.C. Hubbard, N. Andrews, C.E. Downum, A. Miller and J.R. Balsom. 2000. Grand Canyon Monitoring Project 1992-1999: Synthesis and Annual Monitoring Report FY99. Grand Canyon National Park River Corridor Monitoring Report No. 66. Submitted to Bureau of Reclamation, Upper Colorado Region, Salt Lake City

Lomaomvaya, M. , T.J. Ferguson, M. Yeatts. 2001. Ongtuvqava Sakwtala: Hopi Ethnobotany in the Grand Canyon. Submitted to the Grand Canyon Monitoring and Research Center.

Loveless, S. 2000. Bureau of Reclamation Document.

Melis, T.S., and D.M. Rubin. 2003. Testing laser-based sensors for continuous in situ monitoring of suspended sediment. Proc. Oslo Workshop, June 2002. IAHS Publ. 282, 2003.

Melis, T.S. 1997, Geomorphology of debris flows and alluvial fans in Grand Canyon National Park and their influence on the Colorado River below Glen Canyon Dam, Arizona: Ph.D. dissertation, 490 p. University of Arizona, Tucson.

Melis, T. S., R. H. Webb, P. G. Griffiths, and T. W. Wise. 1995. Magnitude and frequency data for historic debris flows in Grand Canyon National Park and vicinity, Arizona: U.S. Geological Survey Water Resources Investigation Report 94-4214, 285p.

Meretsky, V. J. and D. L. Wegner. 1998. Annual report on monitoring of Kanab ambersnail at Vaseys Paradise. SWCA, Environmental Consultants, Inc., submitted to Grand Canyon Monitoring and Research Center, Flagstaff, AZ.

National Academy of Sciences. 1999. Downstream.

Neal, L. A., D. Gilpin, L. Jonas and J.H. Ballagh. 2000. Cultural Resources Data Synthesis Within the Colorado River Corridor, Grand Canyon National Park and Glen Canyon National Recreation Area, Arizona. SWCA, Environmental Consultants, Inc., submitted to Grand Canyon Monitoring and Research Center, Flagstaff, AZ.

NPS. 2005.

NPS. 2004.

Pederson, J. L., P. A. Petersen, W. W. MacFarlane, M. F. Gonzales, and K. Kohl. 2003. Mitigation, monitoring, and geomorphology related to gully erosion of cultural sites in Grand Canyon. Final Report in fulfillment of CA-01-WRAG-0074, on file, Grand Canyon Monitoring and Research Center, Flagstaff.

Pennis, E. 2004. The Grand (Canyon) Experiment. Ecosystems. AAAS, 10 December 2004, vol. 306.

Peterson, J. H. and C. Paukert. 2003. The utility of bioenergetics models in Grand Canyon Fisheries Research, U.S. Geological Survey.

Roberts, C.A. and J.A. Bieri. 2001. Impacts of Low Flow Rates on Recreational Rafting Traffic on the Colorado River in Grand Canyon National Park. Electronic report on file at http://www.gcmrc.gov\library\reports\cultural\Recreation\roberts2001.pdf.

Ruane et al. 2001.

Rubin, D.M. 2004. A Simple Autocorrelation Algorithm for Determining Grain Size from Digital Images of Sediment. Journal of Sedimentary Research, vol. 74, No. 1, January, 2004, p. 160-165.

Rubin, D.M. 2003.

Rubin, D.M., D.J. Topping, J.C. Schmidt, J. Hazel, M. Kaplinski, and T.S. Melis. 2002. Recent sediment studies refute Glen Canyon Dam EIS hypothesis: EOS, vol. 83, no. 25, p. 273 and 277-278, American Geophysical Union, Washington, D.C.

Shelby et al. 1976.

Shelby et al. 1992.

Speas, D.W., C. Walters, T. McKinney, B. Persons. 2001. Population biology of rainbow trout in the Lees Ferry tailwater under varied flow regimes. American Fisheries Society Meeting Abstract.

Shelby, B. 1976. Use levels and crowding in the Grand Canyon, USDI, National Park Service, Colorado River Research Program, River Contact Study, Final Report, Part 3.

Spence, J. 2001. The riparian and aquatic bird communities along the Colorado River from Glen Canyon Dam to Lake Mead, 1996-2000. Partial Draft report submitted to Grand Canyon Monitoring and Research Center, Flagstaff, AZ 86001.

Stevens, L.E., P. Keim and M. Miller. 2000. Morphological and genetic relatedness among succinieid landsnails in the United States and Canada, with emphasis on the endangered Kanab ambersnail (*Oxyloma haydeni kanabensis*). Final report submitted to Grand Canyon Monitoring and Research Center, Flagstaff, AZ 86001.

Stewart, W., et al. 2000. Preferences of recreation user groups of the Colorado River in Grand Canyon. University of Illinois, Carbondale, submitted to Grand Canyon Monitoring and Research Center, Flagstaff, AZ.

SWCA. 1999

Thompson, K. S., A. R. Potochnik, R. Ryel, G. O'Brien, L. A. Neal. 2000. Development of a geomorphic model to predict erosion of pre-dam Colorado River terraces containing archaeological resources. SWCA, Environmental Consultants, Inc., submitted to Grand Canyon Monitoring and Research Center, Flagstaff, AZ.

Topping, D.J., T.S. Melis, D.M. Rubin, S.A. Wright. 2004. High-resolution monitoring of suspended-sediment concentration and grain size in the Colorado River in Grand Canyon using a laser-acoustic system. Proc. of the Ninth International Symposium on River Sedimentation, October 18-21, 2004, Yichang, China.

Urquhart, S., G. T. Auble, J. G. Blake, D. T. Bolger, T. Gerrodetter, S. G. Leibowitz, D. C. Lightfoot, A. H. Taylor. 2000. Report of a peer review panel on terrestrial aspects of the biological resources program of Grand Canyon Monitoring and Research Center.

U.S. Fish and Wildlife Service. 2002. Authors: Van Haverbeke, D. R., L. G. Coggins, Jr. 2002. Stock assessment and fisheries monitoring activities in the Little Colorado River within Grand Canyon during 2001. Draft final report submitted to the Grand Canyon Monitoring and Research Center. U.S. Fish and Wildlife Service, Flagstaff. Doc. No. USFWS-AZFRO-FL-03-002.

Webb, R. H., T.S. Melis, P. G. Griffiths, and J. G. Elliot. 1999. Reworking of aggraded debris fans: *in* R. H. Webb, J. C. Schmidt, G. R. Marzolf, and R. A. Valdez (editors): The Controlled Flood in Grand Canyon, p. 37-52, American Geophysical Union Monograph 110, Washington.

Weeden, H., F. Borden, B. turner, D. Thompson, C. Strauss, and R. Johnson. 1975. Grand Canyon National Park campsite inventory, Contract Number CX001-3-0061 with the National Park Service, Pennsylvania State University, University Park, PA.

Wiele, S.M. 2003. Annual progress report (year-1) on sediment-transport modeling of mainstem flow and sediment dynamics.

Wiele, S.M. and M. Franseen. 2000. Modeling of Mainstem flow and sediment dynamics at selected cultural resource locations. Draft report, under review.

Yard, H. and J. G. Blake. 2002. Breeding bird assessment and surveys. *In* Kearsley et al. Inventory and monitoring of terrestrial riparian resources in the Colorado River corridor of Grand Canyon: An integrative approach. 2002 annual report. Cooperative agreement number 01WRAG0044 and 01WRAG0034. Submitted to USGS/GCMRC.

Yard, H. and N. Cobb. 2001 Bottom-up structuring of avian communities in the Grand Canyon: In search of arthropod indicators. Project report 2000. Submitted to Grand Canyon Monitoring and Research Center, Flagstaff, AZ 86001.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1		**ID**	**Project Descriptions**	**BOR Approved FY04 Budget**	**BOR Approved FY05 Budget**	**BOR Draft FY06 Budget**	**Comments**							
2	**Reclamation Administration *Power Revenue* Funded Projects**													
3		**A**	**Adaptive Management Work Group**											
4		1	Personnel Costs	151,000	155,530	159,418								
5		2	AMWG Member Travel Reimbursement	13,000	13,390	15,725								
6		3	Reclamation Travel	18,000	15,540	13,000								
7		4	Facilitation Contract	21,000	21,000	25,000								
8		5	Other	9,000	7,000	7,175								
9		**BOR AMWG Subtotal**		**212,000**	**212,460**	**220,318**								
10		**B**	**Technical Work Group**											
11		1	Personnel Costs	69,000	71,070	72,847								
12		2	TWG Member Travel Reimbursement	15,000	15,450	20,836								
13		3	Reclamation Travel	17,000	15,510	15,898								
14		4	TWG Chair Reimbursement	21,000	21,630	22,171								
15		5	Other	2,000	2,000	2,050								
16		**TWG Subtotal**		**124,000**	**125,660**	**133,801**								
17		**C**	**Other**											
18		1	Compliance Documents	26,000	26,780	22,450								
19		2	Contract Administration	25,000	25,750	24,394								
20		**ADM**	**Public Outreach**	**85,000**	**50,000**	-	Moved from USGS in FY05 & 06; Ad Hoc formed 1/7/04 to develop program in FY04; HBC included..							
21		**Other Subtotal**		**136,000**	**102,530**	**46,844**								
22		**Reclamation Administrative Subtotal**		**472,000**	**440,650**	**400,964**								
23														
24		**Programmatic Agreement Cultural Resources**												
25		1	Reclamation Administration	43,000	51,500	52,788								
26		2	NPS-GRCA Monitoring Costs	200,000	206,000	-	FY06 Moved under GCMRC Cultural Monitoring budget							
27		3	NPS-GLCA Monitoring Costs	28,000	28,840	-	FY06 Moved under GCMRC Cultural Monitoring budget; completing treatment for FY06, unsure if additional funds needed.							
28		4	NN & GLCA Treatment Plan and Implementation	100,000	100,000	20,000	Should be completed with 20K in FY06							
29		5	Canyon Treatment Plan and Implementation	0	250,000	250,000								
30		6	Zuni Conservation Program Mitigation	0	10,000	-	Covered under treatment							
31		7	TCP GIS Documentation	0	30,000	-								
32		**PA Subtotal**		**371,000**	**676,340**	**322,788**								
33		**Reclamation *Power Revenue* Program Subtotal**		**843,000**	**1,116,990**	**723,752**								
34														

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
35		**Reclamation Administration *NON-Power Revenue* Funded Projects**												
36		HCA	Development of a LCR Management Plan	0	100,000	-	BOR; Includes spill prevention, invasive sp. and pollution control plans							-
37		**Tribal Consultation**												
38		**A**	**Cooperative Agreements with Tribes**											
39		1	Hopi Tribe	80,000	80,000	82,000	TWG requests more info on products in the future							
40		2	Hualapai Tribe	80,000	80,000	82,000	TWG requests more info on products in the future							
41		3	Navajo Nation	80,000	80,000	82,000	TWG requests more info on products in the future							
42		4	Pueblo of Zuni	80,000	80,000	82,000	TWG requests more info on products in the future							
43		5	Southern Paiute	80,000	80,000	82,000	TWG requests more info on products in the future							
44		**Tribal Consultation Subtotal**		**400,000**	**500,000**	**410,000**								
45		**B**	**River Trips for Consulation and DOEs**											
46		1	Hopi Tribe	0	15,000	15,375	TWG requests more info on purpose/products in the future; can there be a tie to GCMRC Tribal Values Monitoring?							
47		2	Hualapai Tribe	0	15,000	15,375	TWG requests more info on purpose/products in the future; can there be a tie to GCMRC Tribal Values Monitoring?							
48		3	Navajo Nation	0	15,000	15,375	TWG requests more info on purpose/products in the future; can there be a tie to GCMRC Tribal Values Monitoring?							
49		4	Pueblo of Zuni	0	15,000	15,375	TWG requests more info on purpose/products in the future; can there be a tie to GCMRC Tribal Values Monitoring?							
50		5	Southern Paiute	0	15,000	15,375	TWG requests more info on purpose/products in the future; can there be a tie to GCMRC Tribal Values Monitoring?							
51		**Tribal River Trip Subtotal**		**0**	**75,000**	**76,875**								
52		**Tribal Subtotal**		**400,000**	**575,000**	**486,875**								
53		**Reclamation *NON-Power Revenue* Subtotal**		**400,000**	**575,000**	**486,875**								
54														
55		**BUREAU OF RECLAMATION TOTAL AMP PROGRAM COSTS:**		**1,243,000**	**1,691,990**	**1,210,627**								
56														
57														

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
58	**GCMRC Work Plan ID**	**ID**	**Project Descriptions**	**Approved FY04 Budget**	**Approved FY05 Budget**	**Outside GCMRC Science/Labor**	**Logistics Field Support**	**Logistics NPS Permitting(1)**	**Project Related Trvl/Training**	**Operations / Supplies**	**GCMRC Salaries**	**Project Subtotal (w/o Burden)**	**DOI Customer Burden (15%)**	**DRAFT FY06 Budget - Gross (inc. Burden)**
59	**U.S. Geological Survey - Biological Resource Division - GCMRC - *Power Revenue* Funded Projects**													
60														
61		**A**	**Physical Sciences, Modeling & DASA**											
62	A.2	CM	Integrated Downstream Water Quality Monitoring	179,000	250,000	500,000	75,000	15,000	15,000	70,000	293,150	**968,150**	145,223	**1,113,373**
63	A.3	CM	Fine-Sediment Storage - **Monitoring**	549,000	250,000	256,250	-	-	-	-	-	**256,250**	38,438	**294,688**
64		CM	Streamflow & SS Transport - **Monitoring**	505,000	500,000	-	-	-	-	-	-	-	-	**-**
65		EXP	SS Mass Balance - **Exp. Support**	420,000	137,500	-	-	-	-	-	-	-	-	**-**
66		RES	Nutrient Flux - Res. Toward Core Mon.	0	0	-	-	-	-	-	-	-	-	**-**
67		RES	SS Transport Modeling	231000	0	-	-	-	-	-	-	-	-	**-**
68		CM	Coarse-Grained Inputs - **Monitoring**	135,000	0	-	-	-	-	-	-	-	-	**-**
69		EXP	Coarse Sediment - **Debris-Fan Reworking**	49,000	0	-	-	-	-	-	-	-	-	**-**
70		EXP	Fine-Sediment Storage - **Extra EXP. Elements**	500,000	750,000	-	-	-	-	-	-	-	-	**-**
71		EXP	Fine-Sediment - **Sand Deposition in Arroyos**	25,000	0	-	-	-	-	-	-	-	-	**-**
72		EXP	Fine-Sediment - **Camping Beach Changes**	25,000	0	-	-	-	-	-	-	-	-	**-**
73		EXP	SS Transport Modeling - Sand Routing Exps.	62,000	0	-	-	-	-	-	-	-	-	**-**
74			**Physical Sciences Subtotal**	**2,680,000**	**1,887,500**	**756,250**	**75,000**	**15,000**	**15,000**	**70,000**	**293,150**	**1,224,400**	**183,660**	**1,408,060**
75														
76			**DASA Activities**											
77	A.4	CM	Air-Remote Sensing - **Monitoring**	163,000	200,000	-	-	-	-	-	82,100	**82,100**	12,315	**94,415**
78	A.5	DASA	Data Base Management System	128,000	128,000	27,200	-	-	3,000	12,000	89,000	**131,200**	19,680	**150,880**
79	A.6	DASA	GIS: Automated Monitoring Technologies & Applications			12,000	-		2,000	10,000	-	**24,000**	3,600	**27,600**
80	A.7	DASA	GIS: GIS General Support for Integrated Analyses & Projects	160,000	160,000	50,200	-	-	5,000	15,000	69,800	**140,000**	21,000	**161,000**
81		DASA	Channel Mapping	90,000	0	-	-	-	-	-	-	-	-	**-**
82			**DASA Subtotal**	**541,000**	**488,000**	**89,400**	**0**	**0**	**10,000**	**37,000**	**240,900**	**377,300**	**56,595**	**433,895**
83	**Physical Sciences, Modeling & DASA Subtotal**			**3,221,000**	**2,375,500**	**845,650**	**75,000**	**15,000**	**25,000**	**107,000**	**534,050**	**1,601,700**	**240,255**	**1,841,955**
84														

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
58	**GCMRC Work Plan ID**	**ID**	**Project Descriptions**	**Approved FY04 Budget**	**Approved FY05 Budget**	**Outside GCMRC Science/Labor**	**Logistics Field Support**	**Logistics NPS Permitting(1)**	**Project Related Trvl/Training**	**Operations / Supplies**	**GCMRC Salaries**	**Project Subtotal (w/o Burden)**	**DOI Customer Burden (15%)**	**DRAFT FY06 Budget - Gross (inc. Burden)**
85		**B**	**BioSciences Program**											
86			**Aquatic & Terrestrial Ecosystem Activities**											
87	B.1	CM	Kanab Ambersnail & SWWF - **Monitoring**	79,000	79,000	55,000	40,000	5,000	5,000	-	87,400	**192,400**	28,860	**221,260**
88	B.2	CM	Aquatic Foodbase - **Monitoring**	248,000	315,000	216,000	85,000	15,000	5,000	-	79,500	**400,500**	60,075	**460,575**
89	B.3	CM	Status & Trends of DS Fish - **Monitoring**	870,000	820,000	550,000	130,000	20,000	5,000	20,000	116,500	**841,500**	126,225	**967,725**
90	B.4	CM	Status & Trends LF Trout - **Monitoring**	161,000	111,000	90,000	8,000	5,000	-	-	-	**103,000**	15,450	**118,450**
91		CM	Terrestrial Ecosystem - **Monitoring**	505,000	300,000	-	-	-	-	-	-	-	-	-
92		CM	Habitat Map & Inventory - **Monitoring**	48,000	0	-	-	-	-	-	-	-	-	-
93		EXP	Primary Productivity, Carbon Flux	59,000	0	-	-	-	-	-	-	-	-	-
94		EXP	Temperatures and Habitat Use Monitoring	200,000	150,000	-	-	-	-	-	-	-	-	-
95		EXP	Kanab Ambersnail Population EHF Impacts	10,000	10,000	-	-	-	-	-	-	-	-	-
96		EXP	Foodbase Impacts of EHF Flows	50,000	0	-	-	-	-	-	-	-	-	-
97		EXP	Spawning Redds & Suppression Mechanisms	175,000	0	-	-	-	-	-	-	-	-	-
98		EXP	Food Base Impacts of Fluctuating Flows	60,000	0	-	-	-	-	-	-	-	-	-
99	B.6	EXP	Mechanical Removal of Non-native Fish	586,000	586,000	240,000	418,000	-	-	-	30,000	**688,000**	103,200	**791,200**
100		EXP	Rainbow Diet Analysis & Predation of Chubs	50,000	50,000	-	-	-	-	-	-	-	-	-
101		HCA	Translocation of Humpback Chub	25,000	50,000	-	-	-	-	-	-	-	-	-
102		HCA	Dam Operations Experiment	50,000	50,000	-	-	-	-	-	-	-	-	-
103		HCA	Scientific, Recreation Impact Assessment	11,000	30,000	-	-	-	-	-	-	-	-	-
104		HCA	Fish Monitoring below Diamond Creek	50,000	50,000	-	-	-	-	-	-	-	-	-
105		HCA	Monitoring Parasites and Diseases	50,000	55,000	-	-	-	-	-	-	-	-	-
106	B.5	HCA	Concurrent LCR, Mainstem HBC Pop Est.	250,000	200,000	59,100	80,000	15,000	-	-	63,500	**217,600**	32,640	**250,240**
107		HCA	HBC Outreach	0	0	-	-	-	-	-	-	-	-	-
108		HCA	Genetics Management Plan	0	0	-	-	-	-	-	-	-	-	-
109		HCA	Sediment, Turbidity Augmentation	50,000	25,000	-	-	-	-	-	-	-	-	-
110		HCA	Sediment Augmentation Feasibility Study	0	50,000	-	-	-	-	-	-	-	-	-
111		HCA	HBC Genetics Evaluation	0	0	-	-	-	-	-	-	-	-	-
112		HCA	Feasibility of HBC Augmentation	0	0	-	-	-	-	-	-	-	-	-
113		**BioSciences Subtotal**		**3,587,000**	**2,931,000**	**1,210,100**	**761,000**	**60,000**	**15,000**	**20,000**	**376,900**	**2,443,000**	**366,450**	**2,809,450**
114														

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
58	**GCMRC Work Plan ID**	**ID**	**Project Descriptions**	**Approved FY04 Budget**	**Approved FY05 Budget**	**Outside GCMRC Science/Labor**	**Logistics Field Support**	**Logistics NPS Permitting(1)**	**Project Related Trvl/Training**	**Operations / Supplies**	**GCMRC Salaries**	**Project Subtotal (w/o Burden)**	**DOI Customer Burden (15%)**	**DRAFT FY06 Budget - Gross (inc. Burden)**
115		**C**	**Sociocultural Program**											
116		CM	Eval. & Plan for Cultural - **Monitoring**	0	0	-	-	-	-	-	-	-	-	-
117	?	RES	1st Yr Geomorph. Model, Process Study	0	135,000	-	-	-	-	-	-	-	-	-
118	Cont FY06?	RES	Implementation of Recreation PEP recommendations	0	40,000	-	-	-	-	-	-	-	-	-
119		RES	Implementation of Socioeconomic PEP recommendations	0	40,000	-	-	-	-	-	-	-	-	-
120		EXP	Tribal Funding for Experimental Flows	0	25,000	-	-	-	-	-	-	-	-	-
121		RES	Tribal Outreach Workshop (Tribal Training/Integration)	45,000	0	-	-	-	-	-	-	-	-	-
122		RES	APE Study	25,000	0	-	-	-	-	-	-	-	-	-
123	C.1	CM	Integrated Archaeological Site Monitoring	~~0~~	~~0~~	234,420	70,000	10,000	-	5,000	20,720	340,140	51,021	**391,161**
124	C.2	CM	Integrated Tribal Values Monitoring	~~0~~	~~0~~	250,000	-	-	-	-	25,000	275,000	41,250	**316,250**
125	C.3	CM	Integrated Campsite Monitoring Program	~~0~~	~~0~~	141,040	35,000	5,000	-	6,000	6,000	193,040	28,956	**221,996**
126		**Sociocultural Program Subtotal**		**70,000**	**240,000**	**625,460**	**105,000**	**15,000**	**0**	**11,000**	**51,720**	**808,180**	**121,227**	**929,407**
127														
128		**D**	**Logistics Support**											
129	D.1	L&S	Logistics (Dispersed throughout projects)			-	-	-	-	100,000	59,700	159,700	23,955	**183,655**
130	D.2	L&S	Survey Operations	126,000	126,000	-	35,000	5,000	-	28,150	61,000	129,150	19,373	**148,523**
131		EXP	Technical Support - Survey Equipment	32,000	32,000	-	-	-	-	-	-	-	-	-
132	D.3	L&S	Control Network	86,000	150,000	-	35,000	5,000	-	51,150	62,600	153,750	23,063	**176,813**
133		**Logistics Support Subtotal**		**244,000**	**308,000**	**0**	**70,000**	**10,000**	**0**	**179,300**	**183,300**	**442,600**	**66,390**	**508,990**
134														
135		**E**	**Information Office**											
136	E.1	IPO	Web page and product development	-	75,000	-	-	-	-	-	-	-	-	-
137	E.2	IPO	Systems Administration	242,000	242,000	-	-		5,000	165,000	129,600	299,600	44,940	**344,540**
138		EXP	Technical Support - Computer	21,000	21,000	-	-	-	-	-	-	-	-	-
139	E.3	IPO	Library	79,000	99,000	23,175	-		4,000	29,250	57,600	114,025	17,104	**131,129**
140		**Information Office Subtotal**		**342,000**	**437,000**	**23,175**	**0**		**9,000**	**194,250**	**187,200**	**413,625**	**62,044**	**475,669**
141														

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
58	**GCMRC Work Plan ID**	**ID**	**Project Descriptions**	**Approved FY04 Budget**	**Approved FY05 Budget**	**Outside GCMRC Science/Labor**	**Logistics Field Support**	**Logistics NPS Permitting(1)**	**Project Related Trvl/Training**	**Operations / Supplies**	**GCMRC Salaries**	**Project Subtotal (w/o Burden)**	**DOI Customer Burden (15%)**	**DRAFT FY06 Budget - Gross (inc. Burden)**
142		**Admin. & Tech. Supp. Services**												
143		**F**	**Administrative & Management**											
144	F.1	ADM	Administrative Operations[1]	620,000	638,600	15,000	-	-	40,000	314,800	262,000	631,800	94,770	**726,570**
145		EXP	Administrative Support	5,000	5,000	-	-	-	-	-	-	-	-	**-**
146	F.2	ADM	Program Planning & Management	274,000	282,220	-	-		15,000	-	465,000	480,000	72,000	**552,000**
147	F.3	ADM	TWG/AMWG Participation	45,000	46,350	-	-		15,000	-	-	15,000	2,250	**17,250**
148	F.4	ADM	Independent Reviews	222,000	272,000	175,000	-	-	-	-	-	175,000	26,250	**201,250**
149		**ADM**	**Public Outreach (Moved to BOR)**	**0**	**0**	-	-	-	-	-	-	-	-	**-**
150		AMP	AMWG, TWG Requests	0	73,000	-	-	-	-	-	-	-	-	**-**
151		AMP	Unsolicted Proposals (Other research activities)	0	50,000	-	-	-	-	-	-	-	-	**-**
152		**Administrative & Management Subtotal**		**1,166,000**	**1,367,170**	**190,000**	**-**	**-**	**70,000**	**314,800**	**727,000**	**1,301,800**	**195,270**	**1,497,070**
153		**Logistics, Info Office & Admin Support Subtotal**		**1,752,000**	**2,112,170**	**213,175**	**70,000**	**10,000**	**79,000**	**688,350**	**1,097,500**	**2,158,025**	**323,704**	**2,481,729**
154		**GCMRC *Power Revenue* Subtotal**		**8,630,000**	**7,658,670**	**2,894,385**	**1,011,000**	**100,000**	**119,000**	**826,350**	**2,060,170**	**7,010,905**	**1,051,636**	**8,062,541**
155														
156		**U.S. Geological Survey - Biological Resource Division - GCMRC - NON-Power Revenue Funded Projects**												
157		**A**	**Lake Powell**											
158	A.1	CM	Lake Powell **Monitoring**	210,000	210,000	-	-	-	10,000	38,924	138,250	**187,174**	28,076	**215,250**
159	B.7	HCA	Temperature Control Device (TCD)	200,000	50,000	173,913	-	-	-	-	-	**173,913**	26,087	**200,000**
160		RES	Kanab Ambersnail Taxonomy (USGS Appr. Only)	88,000	0	-	-	-	-	-	-	-	-	**-**
161		**GCMRC *NON-Power Revenue* Funded Project Subtotal**		**498,000**	**260,000**	**173,913**	**0**	**0**	**10,000**	**38,924**	**138,250**	**361,087**	**54,163**	**415,250**
162														
163		**GCMRC TOTAL AMP PROGRAM COSTS:**		**9,128,000**	**7,918,670**	**3,068,298**	**1,011,000**	**100,000**	**129,000**	**865,274**	**2,198,420**	**7,371,992**	**1,105,799**	**8,477,791**
164														
165														

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
58	GCMRC Work Plan ID	ID	Project Descriptions	Approved FY04 Budget	Approved FY05 Budget	Outside GCMRC Science/Labor	Logistics Field Support	Logistics NPS Permitting(1)	Project Related Trvl/Training	Operations / Supplies	GCMRC Salaries	Project Subtotal (w/o Burden)	DOI Customer Burden (15%)	DRAFT FY06 Budget - Gross (inc. Burden)
166			**BOR & USGS-GCMRC AMP PROGRAM COSTS**	**FISCAL YEAR 2004**	**FISCAL YEAR 2005**	**FISCAL YEAR 2006**								
167			BOR Power Revenue Program Costs	843,000	1,116,990	723,752								
168			GCMRC Power Revenue Program Costs (net)	**7,578,261**	**6,703,191**	7,010,905								
169			GCMRC DOI Customer Burden (Indirect Costs)	**1,136,739**	**1,005,479**	1,051,636								
170			**Subtotal BOR & GCMRC Power Revenue Program Costs**	**9,558,000**	**8,825,660**	**8,786,292**								
171			BOR Non-Power Revenue Program Costs	400,000	575,000	486,875								
172			GCMRC Non-Power Revenue Program Costs	498,000	260,000	361,087								
173			GCMRC DOI Customer Burden (Indirect Costs)	0	0	54,163								
174			**Subtotal BOR & GCMRC Non-Power Revenue Program Costs**	**898,000**	**835,000**	**902,125**								
175			Estimated Cost Share expense required by USGS policy[3]	1,000,000	1,000,000	1,000,000								
176			**TOTAL AMP PROGRAM COSTS (BOR & GCMRC):**	**11,456,000**	**10,660,660**	**10,688,417**								
177														
178			**OTHER AGENCY AMP PROGRAM COSTS**	**FISCAL YEAR 2004**	**FISCAL YEAR 2005**	**FISCAL YEAR 2006**								
179			**US Fish & Wildlife Service**											
180		HCA	HBC Captive Breeding/Refugia	40,000	0	**?**	USFWS responsibility to be completed in FY04							
181		HCA	Willlow Beach genetics Assessment	0	0	**?**	USFWS responsibility to be completed in FY04							
182			**National Park Service**											
183		HCA	Bright Angel Non_Native Fish Removal	167,000	167,000	**?**	NPS Funds; feasibility study initiated							
184		HCA	Tributary Non-native Fish Survey & Removal	0	0	**?**	NPS Funds; feasibility study initiated							
185			**TOTAL AMP PROGRAM COSTS FOR OTHER AGENCIES:**	**207,000**	**167,000**	**0**								
186														
187			**TOTAL AMP PROGRAM COSTS - ALL AGENCIES:**	**FISCAL YEAR 2004**	**FISCAL YEAR 2005**	**FISCAL YEAR 2006**								
188				**11,663,000**	**10,827,660**	**10,688,417**								
189														

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
58	GCMRC Work Plan ID	ID	Project Descriptions	Approved FY04 Budget	Approved FY05 Budget	Outside GCMRC Science/Labor	Logistics Field Support	Logistics NPS Permitting(1)	Project Related Trvl/Training	Operations / Supplies	GCMRC Salaries	Project Subtotal (w/o Burden)	DOI Customer Burden (15%)	DRAFT FY06 Budget - Gross (inc. Burden)

	FUNDING:	FY 2004	FY 2005	FY 2006(2)	
192	USBR & USGS Power Revenues under cap	8,363,000	8,572,000	8,786,300	FY2005 power revenues adjusted per BOR; FY2006 increased by 2.5% CPI
193	FY04 Carry Over	793,000	0	0	
194	FY05 Previously Unidentified Funds (EHF)	0	848,000	0	
195	USGS Appropriations (3)	1,100,000	1,000,000	1,097,375	USGS Appropriations ($1 mil) will be applied to cost share to cover burden difference; amount represents USGS obligation for tribal support
196	USBR Appropriations (4)	295,000	295,000	297,375	BOR appropriations unknown at this time -included $200K for TCD and $97,375 for Tribal Support
197	NPS Funds (5)	167,000	167,000	0	
198	NPS Appropriations (3)	95,000	95,000	97,375	
199	FWS Appropriations (3)	95,000	95,000	97,375	
200	BIA Appropriations (3)	95,000	95,000	97,375	
201	BOR Operations & Maintenance (IQWP)	210,000	210,000	215,250	
202	USGS Funds for Remote Sensing	180,000	0	0	
203	TOTAL AVAILABLE FUNDS	11,393,000	11,377,000	10,688,425	
204	TOTAL FUNDING NEEDED	11,663,000	10,827,660	10,688,417	
205	SUB-TOTAL AVAILABLE FUNDS - ESTIMATED COSTS	(270,000)	549,340	8	
206	Experimental High Flows Testing - 11/2004	0	549,340	8	
207	TOTAL AVAILABLE FUNDS - ESTIMATED COSTS	(270,000)	0	(0)	

210 **RED FONT PROGRAMS ARE THOSE IDENTIFIED AS POTENIALLY UNFUNDED IN *FY2006***

211 **BLUE FONT PROGRAMS ARE THOSE THAT HAVE BEEN COMPLETED IN EITHER FY2004 OR FY2005, ARE SCHEDULED ON A YEAR TO YEAR BASIS,**

212 **OR ARE PLANNED FOR A YEAR BEYOND FY2006. FUNDING WOULD NEED TO BE REDIRECTED BY TWG/AMWG IF THEY ARE TO BE SCHEDULED FOR FY2006.**

213 **BOLD-GREEN FONT REPRESENTS CHANGES AND/OR CORRECTIONS MADE BETWEEN THE PREVIOUS BUDGET SPREADSHEET AND THIS VERSION.**

214 **FY2006 Budget Footnotes:**

215 (1) The Logistics NPS Permitting costs are combined with the Logistics Field Support Line in the Budget Narrative

216 (2) CPI adjustment of 2.5% used for FY2006

217 (3) Cost share is the difference between the USGS full burden rate and the DOI customer rate. USGS full burden rate varies between fiscal years; the DOI customer rate has remained steady since FY2003 (when enacted) at 15%.

218 In FY2006, the *estimated* full burden rate is approximately 37%. The cost share dollars needed would be the difference between the 37% and 15%, or 22%. Cost share dollars are subject to the Cost Center burden rate that varies between years.

219 In FY2006 we estimate the Cost Center rate to be approximately 20%

220 **FY2006 Budget Assumptions:**

221 *It is unknown if the USGS would approve a special "pass-through" rate of 6% for GCMRC; it has not been factored into the budget.

222 *Budget based on the assumption that BOR contributes $200K for TCD

223 *GCMRC budget based on assumption that the DOI Customer Burden Rate remains 15% and that the USGS Bureau contributes approximately $1 million for the cost share portion of the burden.

APPENDIX B

GCMRC Work Plan ID	ID	FY2006 Project Descriptions	MO	CMINS or INS
U.S. Geological Survey - Biological Resource Division - GCMRC - *Power Revenue* Funded Projects				
A	**Physical Sciences, Modeling & DASA**			
A.2	CM	Integrated Downstream Water Quality Monitoring	7.1, 7.2, 7.3, 7.4, 8.1	CMIN 7.1.1, 7.2.1, 7.3.1, 7.4.1, 7.4.2, 8.1.2, 8.1.3
A.3	CM	Fine-Sediment Storage - **Monitoring**	8.1, 8.2., 8.3, 8.4, 8.5	CMIN 8.1.1, 8,2,1, 8.3.1, 8.4.1, 8.5.1
		DASA Activities		
A.4	CM	Air-Remote Sensing - **Monitoring**	Goal 12	CMIN 8.5.1?
A.5	DASA	Data Base Management System	Goal 12	
A.6	DASA	GIS: Automated Monitoring Technologies & Applications	Goal 12	
A.7	DASA	GIS: GIS General Support for Integrated Analyses & Projects	Goal 12	
B	**BioSciences Program Aquatic & Terrestrial Ecosystem Activities**			
B.1	CM	Kanab Ambersnail & SWWF - **Monitoring**	5.1, 5.2, 6.6, 6.7	CMIN 5.1.1, 5.2.1, 6.7.1
B.2	CM	Aquatic Foodbase - **Monitoring**	1.1, 1.2., 1.3, 1.4, 1.5	CMIN 1.1.1, 1.2.1, 1.3.1, 1.4.1, 1.5.1
B.3	CM	Status & Trends of DS Fish - **Monitoring**	2.1., 2.2, 2.3, 2.4, & 4.2 (Goal 4)	CMIN 2.1.1-21.2, 2.4.1, 2.6.1,EIN 2.1.1-2.1.3
B.4	CM	Status & Trends LF Trout - **Monitoring**	4.1	CMIN 4.1.1-4.1.5, 4.1.7
B.5	HCA	Concurrent LCR, Mainstem HBC Pop Est.		
B.6	EXP	Mechanical Removal of Non-native Fish	2.1, 2.4, 4.2	
C	**Sociocultural Program**			
C.1	CM	Integrated Archaeological Site Monitoring	11.1	CMINs 11.1.1., 11.1.2., 11.1.3a, 11.1.4, 11.2.1
C.2	CM	Integrated Tribal Values Monitoring	11.1, 11.2, 11.3, 12.5, 12. 7, 12.8	CMINs 11.1.1., 11.1.3, 11.1.4, 11.2.1
C.3	CM	Integrated Campsite Monitoring Program	9.1, 9.3	CMINs 9.1.1-9.1.3; 9.3.1, 9.3.2; EIN 9.3.1

GCMRC Work Plan ID	ID	FY2006 Project Descriptions	MO	CMINS or INS
D	**Logistics Support**			
D.1	L&S	Logistics (Dispersed throughout projects)		
D.2	L&S	Survey Operations	4.1, 4.2, 5.1, 5.2, 6.4, 7.3, 8.1-8.5, 9.3, 11.1, 12.2, 12.3, 12.9	
D.3	L&S	Control Network	6.4, 7.3, 8.1-8.5, 9.3, 11.1, 12.2, 12.3, 12.9	
E	**Information Office**			
E.1	IPO	Systems Administration	All Mos	
E.2	IPO	Library	All Mos	
F	**Admin. & Tech. Supp. Services - Administrative & Management**			
F.1	ADM	Administrative Operations[(1)]	All Mos	
F.2	ADM	Program Planning & Management	All Mos	
F.3	ADM	TWG/AMWG Participation	All Mos	
F.4	ADM	Independent Reviews	All Mos	
U.S. Geological Survey - Biological Resource Division - GCMRC - NON-Power Revenue Funded Projects				
A	**Lake Powell Water Quality**			
A.1	CM	Lake Powell **Monitoring**	7.1, 7.2, 7.3	CMIN 7.3.1
	HCA	Temperature Control Device (TCD)		