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*July 27, 2005*

**MEMORANDUM**

**To:** M. Gabaldon, Chair and Secretary's Designee, Glen Canyon Dam Adaptive Management Technical Workgroup

**From:** T. Melis, Acting Chief, GCMRC

**Subject:** Transmittal of Draft FY 2006, Work Plan and Budget (version 4.0) for distribution to the Glen Canyon Dam Adaptive Management Workgroup (August 30-31, 2005 AMWG meeting)

Over the last four months, the GCMRC program staff has worked with the Technical Workgroup, as well as members of the Budget and Humpback Chub Comprehensive Planning ad hoc groups to develop a draft FY 2006 work plan and budget to support the identified science needs of the Adaptive Management program. I am please to forward the draft plan to you and the other AMWG members for review prior to the upcoming meeting in August.

At the direction of the AMWG at the March 2005 meeting, two versions of the budget have been developed, one with the GCMRC's recommendation for experimental treatments (Appendix A) and one without (Appendix C). Both can be found as attached Excel files. Input from the ad hoc group members has been incorporated into both versions of the work plan and budget. At their June meeting, the TWG approved a recommendation from the Budget ad hoc for implementation of the version of the plan that includes the GCMRC's recommendation for experimental treatments. However, the TWG also passed two motions that will alter the attached version of the FY 2006 budget (Appendix A) if approved by the AMWG at the August 31, 2005 meeting.

The projects in the work plan that would be amended or added to the work plan by the TWG motions include: 1) revision of the project description and budget associated with Project C.2 (Integrated Tribal Monitoring) and 2) continuation of the one of the Humpback Chub Activities (replication of native fish monitoring below Diamond Creek), implemented by the GCMRC in FY 2004 and 2005, but not recommended for continuation in FY 2006, by the Humpback Chub Comprehensive Planning ad hoc group in spring 2005. I look forward to receiving further direction from the AMWG about which version of the draft plan will be recommended to the Secretary for implementation at the upcoming meeting. Please call me with any additional questions you may have pertaining to the attached draft budget(s) and work plan.

**GLEN CANYON DAM  
ADAPTIVE MANAGEMENT PROGRAM**

**DRAFT  
FISCAL YEAR 2006  
BUDGET & WORK PLAN**

Prepared by

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

and

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

Recommended by the Technical Work Group

**Draft August 1, 2005**

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## **Chapter 1**

### **RECLAMATION ADMINISTRATION**

The Glen Canyon Dam Adaptive Management Work Group (AMWG), a Federal Advisory Committee, is chaired by a designee, appointed by the Secretary of the Interior. Membership is appointed by the Secretary of Interior with representation from each of the cooperating agencies, Colorado River basin states, environmental groups, recreation interests, and contractors for federal power from Glen Canyon Dam.

The formation of an advisory committee has provided a forum of discussion for bringing key issues to resolution. The Secretary of Interior has been mandated to operate the dam and regulate the river in such a manner as to meet the many and varied statutory goals mandated by congress. The AMWG makes it possible for the Secretary to bring all these varied interests to a consensus on how to protect downstream resources and strike a wise balance on river operations.

The following information presents the administrative costs associated with operating the AMWG.

## Reclamation Administration

### A. ADAPTIVE MANAGEMENT WORK GROUP

#### 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
<b>Outside USBR Science/Labor</b>	--	--	--	--	--
<b>Logistics Field Support</b>	--	--	--	--	--
<b>Project Related Travel/Training</b>	--	--	--	--	--
<b>Operations/Supplies</b>	--	--	--	--	--
<b>USBR Salaries</b>	<b>118,990</b>	<b>126,290</b>	<b>110,230</b>	<b>113,537</b>	<b>116,375</b>
<b>Subtotal</b>	<b>118,990</b>	<b>126,290</b>	<b>110,230</b>	<b>113,537</b>	<b>116,375</b>
<b>DOI Customer Burden (27%)</b>	<b>44,010</b>	<b>46,710</b>	<b>40,770</b>	<b>41,993</b>	<b>43,043</b>
<b>Project Total</b>	<b>163,000</b>	<b>173,000</b>	<b>151,000</b>	<b>155,530</b>	<b>159,418</b>
<b>% Total Outsourced</b>	--	--	--	--	--

## 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:** \$15,725

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside USBR Science/Labor	--	--	--	--	--
Logistics Field Support	--	--	--	--	--
Project Related Travel/Training	10,000	10,000	13,000	13,390	15,725
Operations/Supplies	--	--	--	--	--
USBR Salaries	--	--	--	--	--
Subtotal	10,000	10,000	13,000	13,390	15,725
DOI Customer Burden (27%)	--	--	--	--	--
<b>Project Total</b>	<b>10,000</b>	<b>10,000</b>	<b>13,000</b>	<b>13,390</b>	<b>15,725</b>
% Total Outsourced	--	--	--	--	--

### 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%)	--	--	--	--	--
<b>Project Total</b>	<b>18,000</b>	<b>18,000</b>	<b>18,000</b>	<b>15,540</b>	<b>13,000</b>
% Total Outsourced	--	--	--	--	--

#### 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
<b>USBR Reimbursements</b>	25,000	25,000	21,000	21,000	25,000
Logistics Field Support	--	--	--	--	--
Project Related Travel/Training	--	--	--	--	--
Operations/Supplies	--	--	--	--	--
USBR Salaries	--	--	--	--	--
<b>Subtotal</b>	<b>25,000</b>	<b>25,000</b>	<b>21,000</b>	<b>21,000</b>	<b>25,000</b>
DOI Customer Burden (27%)	--	--	--	--	--
<b>Project Total</b>	<b>25,000</b>	<b>25,000</b>	<b>21,000</b>	<b>21,000</b>	<b>25,000</b>
<b>% Total Outsourced</b>	--	--	--	--	--

## 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
<b>Outside USBR Science/Labor</b>	--	--	--	--	--
<b>Logistics Field Support</b>	--	--	--	--	--
<b>Project Related Travel/Training/Awards</b>	6,000	6,000	6,000	5,000	5,000
<b>Operations/Supplies</b>	2,000	2,000	3,000	2,000	2,175
<b>USBR Salaries</b>	--	--	--	--	--
<b>Subtotal</b>	8,000	8,000	9,000	7,000	7,175
<b>DOI Customer Burden (27%)</b>	--	--	--	--	--
<b>Project Total</b>	8,000	8,000	9,000	7,000	7,175
<b>% Total Outsourced</b>	--	--	--	--	--

## Reclamation Administration

### B. Technical Work Group

#### 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
<b>Project Total</b>	<b>74,000</b>	<b>78,000</b>	<b>69,000</b>	<b>71,070</b>	<b>72,847</b>
% Total Outsourced	--	--	-	--	--

## 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
<b>Outside USBR Science/Labor</b>	--	--	--	--	--
<b>Logistics Field Support</b>	--	--	--	--	--
<b>Project Related Travel/Training</b>	<b>10,000</b>	<b>10,000</b>	<b>15,000</b>	<b>15,540</b>	<b>20,836</b>
<b>Operations/Supplies</b>	--	--	--	--	--
<b>USBR Salaries</b>	--	--	--	--	--
<b>Subtotal</b>	<b>10,000</b>	<b>10,000</b>	<b>15,000</b>	<b>15,540</b>	<b>20,836</b>
<b>DOI Customer Burden (27%)</b>	--	--	--	--	--
<b>Project Total</b>	<b>10,000</b>	<b>10,000</b>	<b>15,000</b>	<b>15,540</b>	<b>20,836</b>
<b>% Total Outsourced</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
<b>Outside USBR Science/Labor</b>	--	--	--	--	--
<b>Logistics Field Support</b>	--	--	--	--	--
<b>Project Related Travel/Training</b>	<b>18,000</b>	<b>18,000</b>	<b>17,000</b>	<b>15,510</b>	<b>15,898</b>
<b>Operations/Supplies</b>	--	--	--	--	--
<b>USBR Salaries</b>	--	--	--	--	--
<b>Subtotal</b>	<b>18,000</b>	<b>18,000</b>	<b>17,000</b>	<b>15,510</b>	<b>15,898</b>
<b>DOI Customer Burden (27%)</b>	--	--	--	--	--
<b>Project Total</b>	<b>18,000</b>	<b>18,000</b>	<b>17,000</b>	<b>15,510</b>	<b>15,898</b>
<b>% Total Outsourced</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
<b>Outside USBR Science/Labor</b>	<b>25,000</b>	<b>25,000</b>	<b>21,000</b>	<b>21,630</b>	<b>22,171</b>
Logistics Field Support	--	--	--	--	--
Project Related Travel/Training	--	--	--	--	--
Operations/Supplies	--	--	--	--	--
USBR Salaries	--	--	--	--	--
<b>Subtotal</b>	<b>25,000</b>	<b>25,000</b>	<b>21,000</b>	<b>21,630</b>	<b>22,171</b>
DOI Customer Burden (27%)	--	--	--	--	--
<b>Project Total</b>	<b>25,000</b>	<b>25,000</b>	<b>21,000</b>	<b>21,630</b>	<b>22,171</b>
<b>% Total Outsourced</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
<b>Outside USBR Science/Labor</b>	--	--	--	--	--
<b>Logistics Field Support</b>	--	--	--	--	--
<b>Project Related Travel/Training</b>	--	--	--	--	--
<b>Operations/Supplies</b>	<b>2,000</b>	<b>2,000</b>	<b>2,000</b>	<b>2,000</b>	<b>2,050</b>
<b>USBR Salaries</b>	--	--	--	--	--
<b>Subtotal</b>	<b>2,000</b>	<b>2,000</b>	<b>2,000</b>	<b>2,000</b>	<b>2,050</b>
<b>DOI Customer Burden (27%)</b>	--	--	--	--	--
<b>Project Total</b>	<b>2,000</b>	<b>2,000</b>	<b>2,000</b>	<b>2,000</b>	<b>2,050</b>
<b>% Total Outsourced</b>	--	--	--	--	--

## Reclamation Administration

### C. Other

#### 1. 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
<b>Outside USBR Science/Labor</b>	--	--	--	--	--
<b>Logistics Field Support</b>	--	--	--	--	--
<b>Project Related Travel/Training</b>	--	--	--	--	--
<b>Operations/Supplies</b>	--	--	--	--	--
<b>USBR Salaries</b>	26,000	26,000	26,000	26,780	22,450
<b>Subtotal</b>	26,000	26,000	26,000	26,780	22,450
<b>DOI Customer Burden (27%)</b>	--	--	--	--	--
<b>Project Total</b>	26,000	26,000	26,000	26,780	22,450
<b>% Total Outsourced</b>	--	--	--	--	--

## 2. NPS PERMITTING SUPPORT

**General Project Description:** This project covers the costs for National Park Service administration of permits for research and monitoring conducted under the GCD AMP.

**Project Goals and Objectives:** NPS staff will review and provide permits on request for research and monitoring by GCMRC, other cooperating agencies, and other groups.

**Expected Results:** Research and monitoring conducted under the GCD AMP will receive the appropriate NPS permits so that scientific investigations necessary to the success of this program will be accomplished.

**Budget:** \$100,000

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
<b>Outside USBR Science/Labor</b>	--	--	--	--	--
<b>Logistics Field Support</b>	--	--	--	--	--
<b>Project Related Travel/Training</b>	--	--	--	--	--
<b>Operations/Supplies</b>	--	--	--	--	--
<b>NPS Salaries</b>	--	--	--	--	--
<b>Subtotal</b>	--	--	--	--	--
<b>DOI Customer Burden (27%)</b>	--	--	--	--	--
<b>Project Total</b>	--	--	--	--	<b>100,000</b>
<b>% Total Outsourced</b>	--	--	--	--	--

### 3. 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
<b>Outside USBR Science/Labor</b>	--	--	--	--	--
<b>Logistics Field Support</b>	--	--	--	--	--
<b>Project Related Travel/Training</b>	--	--	--	--	--
<b>Operations/Supplies</b>	--	--	--	--	--
<b>USBR Salaries</b>	25,000	25,000	25,000	25,750	24,394
<b>Subtotal</b>	25,000	25,000	25,000	25,750	24,394
<b>DOI Customer Burden (27%)</b>	--	--	--	--	--
<b>Project Total</b>	25,000	25,000	25,000	25,750	24,394
<b>% Total Outsourced</b>	--	--	--	--	--

## Reclamation Administration

### D. 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:** 0

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
<b>Outside USBR Science/Labor</b>	--	--	--	--	--
<b>Logistics Field Support</b>	--	--	--	--	--
<b>Project Related Travel/Training</b>	--	--	--	--	--
<b>Operations/Supplies</b>	--	--	--	--	--
<b>USBR Salaries</b>	--	--	0	0	--
<b>Subtotal</b>	--	--	0	0	--
<b>DOI Customer Burden (27%)</b>	--	--	--	--	--
<b>Project Total</b>	--	--	85,000	50,000	*
<b>% Total Outsourced</b>	--	--	--	--	--

\* Carry over to FY06 expected to exceed \$75,000, based on May 2005 expenditures, therefore, no FY06 funds programmed. POAHG will present budget request, if necessary, to AMWG.

## Reclamation Administration

### E. LCR MANAGEMENT PLAN

**General Project Description:** This project covers costs of meeting the element of the biological opinion that requires Reclamation to be instrumental in the development of a management plan to protect humpback chub and its critical habitat in the lower Little Colorado River. Some elements of this plan are contained in the humpback chub comprehensive plan.

**Project Goals and Objectives:** The primary goal is to contribute to development of a watershed-based management plan that will identify and address threats emanating from the watershed to humpback chub in the lower Little Colorado River.

**Expected Results:** Funding will be used to develop a watershed-based management plan that addresses threats to humpback chub and its critical habitat in cooperation with agencies, tribes, and organizations that have authority and responsibility for resources in the Little Colorado River basin. Coordination of plan development will be accomplished through the Little Colorado River Watershed Coordinating Council. The plan will address threats identified in the humpback comprehensive plan. Implementation of the plan will require additional funding, but this is not a requirement of the biological opinion.

**Budget:** \$ 100,000

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
<b>Outside USBR Science/Labor</b>	--	--	--	<b>100,000</b>	--
<b>Logistics Field Support</b>	--	--	--	--	--
<b>Project Related Travel/Training</b>	--	--	--	--	--
<b>Operations/Supplies</b>	--	--	--	--	--
<b>USBR Salaries</b>	--	--	--	--	--
<b>Subtotal</b>	--	--	--	<b>100,000</b>	<b>0</b>
<b>DOI Customer Burden (27%)</b>	--	--	--	--	--
<b>Project Total</b>	--	--	--	<b>100,000</b>	<b>0</b>
<b>% Total Outsourced</b>	--	--	--	--	--

## **Reclamation Administration**

### **F. Programmatic Agreement**

#### **1. Reclamation Administration Costs for Programmatic Agreement**

**Rationale/Problem Statement:** Through FY2005 Reclamation's regional archeologist administered the PA program, tribal consultation cooperative agreements and river trip fund transfers to GCMRC. Beginning in FY2006, tribal consultation will be administered through sole source contracts and no portion of the appropriated tribal funding will be transferred to GCMRC. The river trips will be funded by the tribes with dollars received under contract to the Bureau of Reclamation. 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 tribal and other PA related contracts and cooperative agreements, 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 and contract administration for competed projects.

**Project Accomplishments:** Moving towards completion of the stipulations in the PA.

**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
<b>Outside USBR Science/Labor</b>	--	--	--	--	--
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%)	--	--	--	--	--
<b>Project Total</b>	<b>50,000</b>	<b>50,000</b>	<b>43,000</b>	<b>51,500</b>	<b>52,788</b>
% Total Outsourced	--	--	--	--	--

## 2. NPS-Monitoring in Grand Canyon and Glen Canyon

**Rationale/Problem Statement:** Consistent with the requirements of the PA, the NPS has implemented a monitoring and remedial action plan for several years in both Glen and Grand Canyons. The five-year cooperative agreements, initiated in FY2000, were completed in FY2004. Two new one-year Interagency Agreements were executed in FY2005 in order to complete required GIS, database and mapping tasks prior to the transfer of monitoring responsibilities to GCMRC in FY2006.

**Integration:** Not applicable.

**Expected Products:** During FY2005, Grand Canyon NPS will 1) complete GIS polygon mapping of 100 to 160 cultural properties slated for management under a treatment plan, 2) normalize the extant Microsoft Access monitoring and IMACS database, 3) analyze the database in order to eliminate redundant or uninformative variables, and 4) monitor the effectiveness of erosion control devices. Glen Canyon NPS will assist in the ongoing development of the Glen Canyon treatment plan. Funding for this work has been moved to GCMRC in FY 2006.

**Recommended Approach:** FY2005: On-site observation, evaluation and GIS mapping of Grand Canyon cultural resources by NPS. Subcontract the database development to a certified database management consultant. On-site observation of contracted archaeological and geomorphological work conducted during the development of the Glen Canyon treatment plan. FY2006: Transfer GIS and database files to GCMRC.

**Status:**

**External Project Awards:** Subcontract for database restructuring.

**Project Accomplishments:** Mapping of historic properties. Database completion. Recommendations regarding the efficacy of erosion control devices.

**Schedule:** Glen Canyon NPS is based on the fiscal year. Grand Canyon NPS was allowed an extension to January 2, 2006 to complete the requirements due to delays in IA implementation.

**Budget:** \$ 0

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
<b>Outside USBR Science/Labor (Monitoring)</b>					
Grand Canyon	200,000	200,000	200,000	206,000	
Glen Canyon	28,000	30,000	28,000	28,840	--
<b>Logistics Field Support</b>					--
<b>Project Related Travel/Training</b>					--
<b>Operations/Supplies</b>					--
<b>USBR Salaries</b>					--
<b>Subtotal</b>	<b>228,000</b>	<b>230,000</b>	<b>229,000</b>	<b>234,840</b>	--
<b>DOI Customer Burden (27%)</b>					--
<b>Project Total</b>	<b>228,000</b>	<b>230,000</b>	<b>229,000</b>	<b>234,840</b>	<b>0</b>
<b>% Total Outsourced</b>					--

Funding for FY 2006 contained in GCMRC Project C.1, page 61.

### 3. NPS-Grand Canyon and Glen Canyon Treatment Plans

**Rationale/Problem Statement:** In consultation with Grand Canyon NPS and the Hualapai Tribe, begin implementation of a treatment plan for the cultural resources of Grand Canyon based upon a treatment plan design completed with FY2005 funding. Treatment of individual properties may include additional documentation/recordation, in situ preservation measures or full data recovery.

It is anticipated that the bulk of development of the Glen Canyon treatment plan will be completed in FY2005 with implementation to begin in FY2006. Additional funds may be required in FY2006 to finish the reporting task.

Administration of Glen Canyon and Grand Canyon cultural resource monitoring will be transferred to GCMRC in FY2006. Funding for FY2006 identified in the following table is for implementation of the treatment plans only.

**Integration:** Not applicable.

**Expected Products:** Re-evaluations of all affected Glen and Grand Canyon properties for eligibility to the National 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 up to and including 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:** Cooperative Ecosystem Studies Units (CESU) agreements for Grand Canyon. Continuation of the extant cooperative agreement for Glen Canyon.

**Project Accomplishments:** The development of the Glen Canyon treatment plan began in March, 2005, followed by treatment plan implementation in FY2006. A CESU agreement will be awarded in FY2005 for the Grand Canyon treatment plan with work to begin in that year. Implementation of that plan will be accomplished with additional CESU agreements.

**Schedule:** The schedule is based on the fiscal year.

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

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
<b>Outside USBR Science/Labor (Treatment)</b>					
Grand Canyon			0	250,000	250,000
Glen Canyon			100,000	100,000	20,000
<b>Logistics Field Support</b>	--	--	--	--	--
<b>Project Related Travel/Training</b>	--	--	--	--	--
<b>Operations/Supplies</b>	--	--	--	--	--
<b>USBR Salaries</b>	--	--	--	--	--
<b>Subtotal</b>	--	--	100,000	350,000	270,000
<b>DOI Customer Burden (27%)</b>	--	--	--	--	--
<b>Project Total</b>	--	--	100,000	350,000	270,000
<b>% Total Outsourced</b>	--	--	--	--	--

#### 4. Zuni TCP GIS Documentation

**Rationale/Problem Statement:** The PA requires migration of adverse effects of dam operations to Native American traditional cultural properties (TCPs). This project will accomplish the necessary first steps in determining the location and National Register eligibility of Zuni TCPs in the river corridor.

**Integration:** The project is a component of the Historic Preservation Plan.

**Expected Products:** A National Register determination of eligibility form for the identified TCPs. A GIS database and descriptive documentation (sensitive data will be retained by the Pueblo of Zuni). Recommendations of effect and mitigation.

**Recommended Approach:** A combined ethnographic and GIS study.

**Status:** Pending

**External Project Awards:** A sole source contract was executed in FY2005 with the Zuni Cultural Resource Enterprise.

**Project Accomplishments:** Pending

**Schedule:** The work will be accomplished by the end of FY2006.

**Budget:** Total expenditure will be \$30,000.

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
<b>Outside USBR Science/Labor</b>	--	--	--	<b>30,000</b>	<b>0</b>
<b>Logistics Field Support</b>	--	--			
<b>Project Related Travel/Training</b>	--	--			
<b>Operations/Supplies</b>	--	--			
<b>USBR Salaries</b>	--	--			
<b>Subtotal</b>	--	--			
<b>DOI Customer Burden (27%)</b>	--	--			
<b>Project Total</b>	--	--		<b>30,000</b>	<b>0</b>
<b>% Total Outsourced</b>	--	--			

## **Reclamation Administration**

### **G. Tribal activities in support of GCDAMP: Sole Source Contracts with Tribes**

**Rationale/Problem Statement:** Involvement in GCDAMP activities will be maintained among the five AMP tribes (Hopi Tribe, Hualapai Tribe, Southern Paiute Consortium, Pueblo of Zuni, Navajo Nation), the Federal agencies (U.S. Geological Survey, National Park Service, U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, the Bureau of Indian Affairs, Western Area Power Administration), and other members of the GCDAMP.

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

**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 contracts. 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:** Beginning in FY2005, tribal contracts have been funded through appropriated dollars provided by five Department of the Interior agencies (USBR, NPS, FWS, BIA, and USGS). The initial funding level was \$95,000 per tribe, to be incremented each year thereafter by the CPI. These funds are transferred to Interior via Reimbursable Support Agreements (RSAs) with each agency and, in turn, transferred to Reclamation via an RSA for administration of the tribal contracts. Reclamation's contract administration is funded by power revenues.

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

**Schedule:** Contract options are exercised annually at the discretion of the Federal government. Each funded tribe must submit quarterly invoices itemizing expenditures for tasks specified in the contracts. In addition, each tribe must submit a yearly status report to Reclamation at the close of the contract year. Receipt of annual reports must occur within 90 days of the close of the contract. Copies of the reports may be distributed to AMP stakeholders upon request.

**Budget:** The cost is \$489,250 with each agency contributing \$97,850:

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
<b>Outside USBR Science/Labor</b>	<b>400,000</b>	<b>400,000</b>	<b>320,000*</b>	<b>475,000</b>	<b>486,875</b>
Logistics Field Support	--	--	--	--	--
Project Related Travel/Training	--	--	--	--	--
Operations/Supplies	--	--	--	--	--
USBR Salaries	--	--	--	--	--
<b>Subtotal</b>	<b>400,000</b>	<b>400,000</b>	<b>320,000</b>	<b>475,000</b>	<b>486,875</b>
DOI Customer Burden	--	--	--	2,375	2,375
<b>Project Total</b>	<b>400,000</b>	<b>400,000</b>	<b>320,000</b>	<b>477,375</b>	<b>489,250</b>
<b>% Total Outsourced</b>	--	--	--	--	--

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

## **Tribal Activities to Support the GCDAMP: 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 FY05 these costs will be administered through contracts between Reclamation and the Tribes. The tribes will select the approach they take to the trips within this cost constraint and meeting NPS minimum tool requirements.

**Status:** Dependent on contract agreement.

**External Project Awards:** None.

**Project Accomplishments:** The Tribes will be 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:** The budget is 0. Cost is carried above under Sole Source Contracts with the Tribes. The tribes elect whether or not to conduct river trips under their agreement with Reclamation.

FUNDING HISTORY	Fiscal year				
	2002	2003	2004 *	2005	2006
<b>Outside USBR Science/Labor</b>	<b>75,000</b>	<b>75,000</b>	<b>75,000</b>	<b>0</b>	<b>0</b>
Logistics Field Support	--	--	--	--	--
Project Related Travel/Training	--	--	--	--	--
Operations/Supplies	--	--	--	--	--
USBR Salaries	--	--	--	--	--
<b>Subtotal</b>	<b>75,000</b>	<b>75,000</b>	<b>75,000</b>	<b>0</b>	<b>0</b>
DOI Customer Burden (27%)	--	--	--	--	--
<b>Project Total</b>	<b>75,000</b>	<b>75,000</b>	<b>75,000</b>	<b>0</b>	<b>0</b>
<b>% Total Outsourced</b>	--	--	--	--	--

\* \$15,000 for each tribe was provided to GCMRC from appropriated funds.

## CHAPTER 2

### THE GCMRC'S DRAFT FY 2006 ANNUAL WORK PLAN

#### INTRODUCTION

The Fiscal Year 2006 (FY 2006), Grand Canyon Monitoring and Research Center's (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 (GCD-AMP). 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; DOI, 1996) for the *Final - Operations of Glen Canyon Dam Environmental Impact Statement* (DOI, 1995). Owing to many planning activities that are currently ongoing in FY 2005-06, this draft work plan is proposed as a provisional or transitional stepping-stone in the pathway to a next phase of strategic science implementation in support of the needs of the active Adaptive Management program for managing Glen Canyon Dam operations.

#### STRATEGY FOR DEVELOPMENT OF THE WORK PLAN

**The GCMRC's Need for a Strategic Science Implementation Plan** - In response to constraints on science funding for the GCD-AMP, combined with an expanding assortment of research and monitoring needs identified by stakeholders, the GCMRC critically evaluated 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 during winter 2005. This was done in an attempt to balance the critical needs of the program as a new science strategy is developed within the context of the FY 2006 work plan and budget. During the early stages of work plan and budget development, the GCMRC also recognized the need on the part of the program to develop a new *Strategic Science Implementation Plan* (SSIP) that would chart the course of science activities from 2006 through 2010. To be most effective, the SSIP needs to be drafted during 2005-06, and critically needs to contain strategic sub-elements, such as the *Core-Monitoring, Humpback Chub Comprehensive and Research* (including *Experimental*) Plans. Such plans are now being developed jointly with

stakeholders towards a recommendation for implementation (presumably, starting with the FY 2007-08 work plan) by the Adaptive Management Workgroup in FY 2007 budget and beyond.

**Identifying a Strategic Planning Process** - A prospectus for undertaking development of the SSIP was prepared during spring 2005, by the Executive Director of the Science Advisors (L.D. Garrett) and the Secretary's designee and the TWG members were then briefed about the proposed approach strategic approach. Afterwards, initial steps in this planning process began through meetings with the Technical Workgroup's Budget, Core-Monitoring, Experimental and Humpback Chub Comprehensive Plan ad hocs. These initial ad hoc meetings with GCMRC staff provided a solid basis for the following draft work plan during many hours of discussions. As a result of these deliberations with the Technical Workgroup members, numerous recommendations, both in general program approach, as well as specific to individual projects were considered by the GCMRC during revision of this work plan. To effectively chart the course of science in support of the GCD-AMP in its 2006-1010 next phase, an agreed upon strategic science implementation plan is essential to ensure continuing progress in the adaptive management process. In part, this draft work plan represents the beginning of the strategic science planning process.

**Core Monitoring to Document the Influence 1996 Record-of-Decision** – This program 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, conductivity and suspended-sediment transport within the main channel of the Colorado River ecosystem and its major tributaries described within provisional monitoring project A.2. Monitoring projects should evolve through time on the basis of the identification of new information needs that focus on more complex ecosystem functions and responses to dam

operations. For instance, additional elements of monitoring for water quality, such as nutrients, may be added to this project in direct response to basic efforts related to other research projects, such as the aquatic food web initiative, started in FY 2005 (see research and development project, B.2, below). The Core-Monitoring ad hoc group (CMP) is also undertaking a process to fully evaluate projects described in this work plan as “provisional monitoring” in an attempt to clearly identify the elements of the ongoing work that directly meet the information needs specified in the *GCD-AMP Strategic Plan* (see APPENDIX B with project associations).

**Research & Development to Improve Monitoring** – This has been a fundamental component of the GCMRC activities since the Center was established in 1995, as a process of review and science activities (described in the GCMRC’s *Prospectus for Protocol Evaluation* Panel activities) intended to support development of a Long-Term Monitoring program for the Colorado River ecosystem. Ongoing R&D activities, such as those related to aquatic ecosystem productivity and camping areas, 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. Later meetings focused on terrestrial and aquatic parts of the science program. 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. Following the research and development and review phases, elements of long-term, core monitoring should be implemented in ways that meet the needs of the program, are cost effective and result in consistent and comparable data into the future.

**“Active Adaptive Management” [Completing Phased Experimental Treatments]** – Completion of experimental treatments originally recommended by the GCMRC in 2002, has been identified as a high priority in the FY 2006 draft work plan. The 2002 Experimental Plan focused on both sediment and biological tests, so the initial 2003-06 phase of the experimental strategy relates to an assessment of knowledge with respect to: 1) implementation of the fourth year of mechanical removal of non-native fishes, 2) completion of analyses related to the November 2004, sediment High-Flow flow release and 3) continuation of studies related to experimental fluctuating flows during winter, are also an objective for completing the 2003-2006

experimental work. Fiscal Years 2005-06, are specifically intended to be a milestone period in the experimental process in terms of assessing the knowledge gained through testing of these specific flow and non-flow treatments (Mechanical Removal, BHBF's, revised implementation of the BHBF concept and less-constrained fluctuating flows intended to disadvantage non-native fish). During summer 2005, Knowledge Assessment workshops aim to identify remaining uncertainties related to the experimental treatments being tested in the Colorado River below the dam. This information provides the basis for identifying approaches and an experimental design that will hopefully be recommended for implementation as a second phase of experimentation, presumably starting with the FY 2007-08 combined work plan.

**Recommendation for Experimental Treatments in FY 2006** – Within its draft FY 2006 work plan, the GCMRC identifies two experimental treatments that are recommended for continued implementation during Water Year 2006 (starting in October 2005). These activities are also intended to provide continuity between the initial period of experimental efforts and the next phase that is approved and implemented. The first of these treatments, Mechanical Removal of non-native fish, was recommended as a four-year treatment in the GCMRC's 2002, experimental plan. The FY 2006 effort represents the fourth and final year of this recommended experimental treatment. 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. However, the implications of reducing the non-native trout population below Lees Ferry with respect to benefits to native fish recruitment are not yet known.

The second recommended treatment (return to MLFF during January through April, 2006) consists of field and modeling studies relating Experimental versus Modified Low-Fluctuating Flows to rainbow trout reproduction within the Lees Ferry and Upper Marble Canyon reaches. Results of experimental studies related to Experimental Fluctuating Flows (5,000 to 20,000 cfs daily range) during 2003-05, and related modeling simulations, suggest that the experimental flows were probably not a mechanism for increased rainbow trout mortality (with respect to either redds or fry) compared to normal MLFF operations, had they occurred during that time period. To verify or refute these simulation results, a return to normal MLFF operations during January through April 2006, is required to determine through field data,

whether or not the conclusions from this study are valid (see additional information below on *Experimental Update*, see **APPENDIX D for further information on these studies**).

Owing to several factors, the GCMRC does not include another High-Flow Sediment component in its experimental recommendation at this time. These factors include: 1) uncertainty about conducting another high-flow sediment test until the results of the November 2004 experiment are more certainly known and reported to the stakeholders at the October 2005 Science Symposium (a concern expressed by AMWG members at their March 2005 meeting), 2) uncertainty related to influence of the November 2004 test on juvenile native fish downstream of the Little Colorado River and potential for a repeat of such actions to confound biological science aimed at identifying a humpback chub recruitment signal in the reach as a possible response to the Mechanical Removal treatment, and 3) current fiscal limitations projected for the FY 2006 science budget that would preclude simultaneous implementation of both Mechanical Removal activities **AND** replication of intensive field studies (and remote sensing) required to compare the results of a 2006 sediment test with results from the November 2004 experiment.

With implementation of the November 2004 sediment experiment, the experimental fund for this activity, originally created from budget in 2001-03, has been exhausted. A minimal cost associated with replicating the November 2004 sediment studies is thought to be in the range of about \$1,500,000 beyond what is available in the FY 2006 projected budget. Hence, to conduct another similar-scale sediment experiment in 2006, additional funds need to be obtained beyond what is available in the draft 2006 budget. A portion of the required funds might be obtained during FY 2007, from cessation of Mechanical Removal activities after 2006 (approximately, \$800,000). The other portion of the required funds might also be derived from a strategic carry-forward account created within the 2006 budget. On the basis of this information, the Technical Workgroup's Budget ad hoc resolved that a combination of both approaches be considered in a strategy to actively develop a new fund for experimental work that would presumably start in FY 2007. If additional sediment high-flow tests are deemed unnecessary following knowledge assessment activities, then the carry-forward fund would still be available to support biological experimentation or other monitoring and research aimed at further reducing management uncertainties, as outlined in the strategic science implementation plan.

The FY 2006 work plan experimental recommendation is intended to allow completion of two important biological experimental treatments. The proposed work 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.

**Two Budget Scenarios (and Potential for Experimental Fund)** - The draft budget associated *with the GCMRC's experimental treatment recommendation* is shown in **APPENDIX A**. At the March 2005, meeting of the AMWG, members passed a motion requesting the GCMRC and the Budget ad hoc group to develop an alternative "Non-Experimental" version of the FY 2006 budget. This version of the budget has been created (without implementation of either of the above recommended treatments) and through this approach, an experimental carry-forward fund of just over \$1,000,000 can be generated. The GCMRC and the Budget ad hoc also resolved an experimental carry-forward of about \$600,000, within the "With-Experiment" version of the budget. These carry-forward strategies were intended to: 1) provide a new experimental fund to support implementation of the next phase of experimental work, perhaps as early as FY 2007 and 2) allow a period of reduced science activities in FY 2006, while the strategic Science Implementation Plan is completed; including sub-elements related to monitoring and research approved by AMWG.

The alternative draft budget associated with the AMWG's request for a *NON-experimental work plan and budget recommendation* is shown in **APPENDIX C**. The identified carry-forward amount to support future experimental work in FY 2007-08, is projected to be approximately \$1,000,000 in this non-experimental scenario.

**Identified Priorities & Expansion of Socio-Cultural Program** – This theme was seriously embraced by the GCMRC during development of the FY 2006 work plan, in response to priorities identified by the AMWG at their August 2004 meeting. The desire to increase the available information related to recreational and culture resources was identified as second only to fishery objectives by members of the GCD-AMP, with the need to complete other research activities, including experimentation. However, the identified need to complete science planning activities in FY 2006, as well as the projected costs for full implementation of new socio-cultural activities caused the Budget ad hoc and the GCMRC to recommend limiting startup of new research and monitoring activities (campsite and tribal values) during FY 2006, until the Strategic Science Implementation Plan and its various sub-elements for research and monitoring,

was completed. These new projects are still scheduled for startup in FY 2006, but at a reduced level while planning efforts continue, and with sufficient support to allow scientists and stakeholders opportunities for active participation in the strategic science planning process. Following completion of planning activities, these and other projects may be fully implemented in 2007 (following approval of the monitoring and research modules of the SSIP).

**Focused Support for Humpback Chub Actions** – Several conservation measure activities were implemented during FY 2003-2005, related to humpback chub. Some of these activities were directly tied to the Environmental Assessment completed in 2002, allowing experimental treatments to be implemented in 2003-05. 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 Comprehensive Plan* (HBCCP) by the Adaptive Management Work Group, the HBCCP ad hoc proposed to the Budget ad hoc and the GCMRC that **three** areas of the draft Plan be funded in the FY 2006 budget: 1) continuation of the USFWS's translocation of humpback chub above Chute Falls within the Little Colorado River (see project B.8), 2) continuation of funding for *Dam Operations Experiment* planning activities (see project B.9), and 3) implementation of the study plans associated with the Temperature Control Device related to the supplemental EA in fall 2005 (see project B.11).

The Budget ad hoc also recommended that funds for concurrent population estimates (see project formerly designated as ~~B-5~~) be budgeted in the FY 2007 rather than FY 2006, owing to the fact that simulation results now being generated will not likely be available in time to plan and implement such an effort during winter and spring 2005-06. The GCMRC strongly concurs with this recommendation, owing to the uncertainties about whether logistics support needs for both concurrent population estimates and the fourth year of Mechanical Removal can even be met simultaneously in the 2005-06 time period. If such estimates are not deemed essential to the program, then the FY 2007 funds would become available for support of other research and monitoring activities, such as ongoing implementation of experimental treatments or other monitoring and research.

In the FY 2006 work plan, the GCMRC proposes what the staff believes is a balanced fiscal approach to science programming that continues focused research tied to development of: *Core Monitoring, Research & Experimentation, Humpback Chub Comprehensive* and overall

*Strategic Science Implementation Plans*, as well as completing experimental flow and non-flow treatments outlined in the GCMRC's 2002 Experimental Plan. In essence, the FY 2006 work plan and budget provides a natural point for ending an earlier GCMRC phase of research and development activities related to certain resource areas, such as sediment, and allows for new knowledge about experimental results to be assessed in planning a more focused next phase. These activities provide an opportunity to direct the science activities of the program to areas where large uncertainties still exist and where experimental work is still required to reduce those uncertainties. This is an important step toward identifying future options for achieving management objectives. The GCMRC concurs with the various Technical Workgroup ad hocs in promoting the idea that FY 2006 provisional and planning approach is the most logical strategy to follow until FY 2007, when research and monitoring plans are developed and adopted for implementation under available funding. If one sees the last twenty years of science activities as consisting of four distinct (five-year) phases of the program, then the 2006 through 2010 period represents the fifth phase of this environmental science and management effort. In this fifth phase, the GCMRC intends to promote studies that further reduce uncertainties associated with management of critical resources of concern.

### **GEOGRAPHIC SCOPE**

The geographic scope of the Glen Canyon Dam Adaptive Management Program (GCD-AMP) 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,

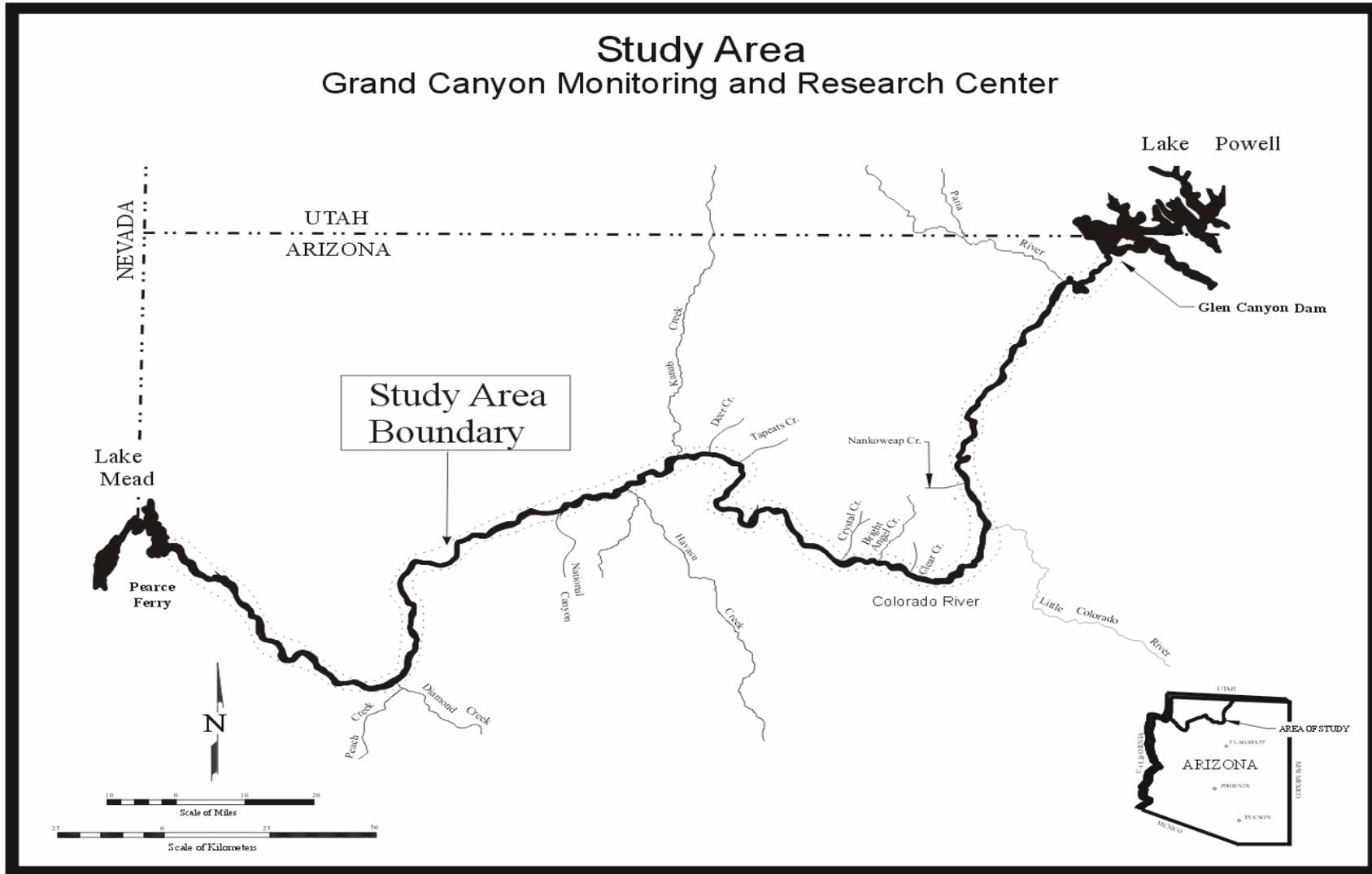


Figure 1.1. Map of the Colorado River Ecosystem (GCMRC Study Area).

considering ecosystem processes, management alternatives, funding sources, and stakeholder interests,” (NRC, 1999:43; Loveless, 2000).

The GCMRC’s 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). Annual GCMRC activities include limited investigations into tributaries (e.g., the Little Colorado and Paria Rivers) and reservoirs (e.g., Lake Powell). The GCD-AMP, 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 GCD-AMP 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](http://www.uc.usbr.gov/amp/amwg/02jan17/Attach_06.pdf)).

### **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 final EIS on Operations of Glen Canyon Dam (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 GCD-AMP. To accomplish these goals, specific

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

## **MANAGEMENT OBJECTIVES AND INFORMATION NEEDS**

### **Introduction**

Management objectives (MO's) and information needs (INs) help the science program managers to focus studies on both measurable and attainable standards relating to future resource conditions associated with the GCD-AMP's Strategic Plan. The MO's and INs also drive the strategic planning process and they provide the basis for the annual monitoring and research program described in this plan (see **APPENDIX B** for details on how this information is generally linked to proposed science activities). Both science cooperators and external peer reviewers look to the GCD-AMP for insight about the goals and objectives of the Adaptive Management effort, as well as the details about what specific conditions are desired for the various resources of the river ecosystem. The challenge of clearly identifying the desired resource conditions below the dam is a difficult but essential task of the AMWG and its Technical Workgroup if the GCD-AMP Strategic Plan objectives are to be linked closely with monitoring and research efforts. Clear identification by managers of "evaluation criteria" for discerning when environmental objectives for downstream conditions are being met is ongoing. One primary objective of the GCMRC's Strategic Science Implementation Plan, is to ensure that science activities evolve to best meet the needs of the GCD-AMP as these evaluation criteria are more clearly defined.

### **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

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1 Operating Protocols for GCMRC, June, 1996.

2 GCMRC Peer Review Guidelines, October 26, 2001.

new set of MO's that resulted from its effort to develop an GCD-AMP strategic plan. The full GCD- strategic plan was completed in FY 2002-03.

### **Revision Process**

As part of the GCD-AMP strategic planning process, the INs were revised and approved by the AMWG in August 2003. The approved MO's and INs are listed in **APPENDIX B**.

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 MO's addressed by the monitoring and research activities proposed in this plan are listed in **APPENDIX B** and referenced in the project descriptions.

### **GCMRC's PROPOSED SCIENTIFIC ACTIVITIES**

The FY 2006 Work Plan describes monitoring and research activities that address the management objectives (MO's) and information needs (INs)<sup>3</sup> of the GCD-AMP to the extent allowed under current funding (see **APPENDIX B**). Projects described as provision with respect to long-term monitoring (see column B of **APPENDICES A and C**), are designed to determine changes in resource attributes. These science projects are currently being reviewed by external experts on a technical basis, as well as being evaluated by the Technical Workgroup's Core-Monitoring Plan ad hoc group (CMP) with respect to their appropriateness in meeting the designated information needs of the overall GCD-AMP. Research is used to improve monitoring, interpret and explain trends observed from monitoring - most critically to determine cause-and-effect relationships with dam operations (or other non-dam influences) and complex resource interactions or associations, and to better define interrelationships among physical, biological and social processes. The GCMRC is lead on the development of the Strategic Science Implementation Plan (SSIP) and within that activity is also leading the way toward a research plan, including a next-phase experimental design to follow the experimental work of 2003-2006, as well as development of a core-monitoring plan.

In addition, GCMRC has responsibility for management and dissemination of technical information in the GCD-AMP program. Included, is development and maintenance of its sophisticated Oracle database management system for archiving data collected as a result of

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<sup>3</sup> The MO's and the IN's are currently undergoing revision. This Work Plan references the draft revised MO's. The INs are being revised and they are not included in this document.

monitoring and research activities, maintenance of a geographic information system for analysis and archiving of spatial data, and a 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 Southwest Biological Science Center's GCMRC website ([www.gcmrc.gov](http://www.gcmrc.gov)). GCMRC also operates a surveying department designed 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.

For additional details regarding individual program area overviews, as well as updated information about the status of resources derived from the science program activities, please refer to **APPENDIX D**. In addition, the GCMRC shall be distributing its report on the State of the Colorado River Ecosystem (SCORE) report in fall 2005. This report will provide information on the status and trends of resources of the Colorado River in response to the current operating policy (1996 ROD).

## **OVERVIEW OF SCIENCE COORDINATION AND SUPPORT**

Implementation of the GCMRC mission to provide credible, objective scientific information to the GCD-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
- Data Acquisition, Storage, Analysis (DASA), DBMS & Library Operations
- Survey Support Coordination
- DASA's GIS 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, Permittees, 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 Permittee 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.**

DASA's Database Management System (DBMS) and Library Operations - Interaction within the DASA's DBMS and Library Operations, as well as coordination with the SBSC Information Technologies Department and other GCMRC staff, is a vital component in the success of the support of GCMRC's monitoring and research projects. The philosophy of the DASA is that data acquisition is the first step to any science analysis done in support of meeting the information needs of the GCD-AMP. Once data are acquired, they must be securely stored, but also made readily available for use. The ultimate use of the data is for focused analyses to achieve the learning required to link dam operations to changes detected in downstream resources. The data are also needed within the context of a high-powered, relational database if integrated science is to be achieved. Conversion of analog "legacy" data from previous eras (such as analog stereo air photo sets) to digital files is a form of data acquisition and is the first step toward eventual orthorectification of these images if they are to be photogrammetrically analyzed to extend historical time series back into the pre-digital age. Hence, such data conversion is most logically conducted and oversights by the same group that will facilitate and lead the final analyses. Such an approach promotes the highest quality results from integrated analyses. Coordination with DASA/Library Operations facilitates the support of research activities in three key aspects:

1. The Library provides a centralized repository for remaining hard copy information such as books, reports, maps, photography, and videos that are not easily provided through the GCMRC web site in digital format.
2. A major objective and growing function of the database and library is to provide stakeholders, cooperators, and other interested parties, with ready electronic access to most of the library's materials (once scanned and stored in the Oracle data engine) that are uniquely a part of the GCMRC archival collection. Access is facilitated via the internet through the SBSC-supported web page(s).
3. 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.

DASA's Additional GIS 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.
- Analog-to-Digital Data conversion of the GCMRC's archive of historical, analog aerial photography.

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 ongoing coordination and cooperation between the GCMRC staff and the SBSC's Information Technology Director and staff.

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, kinematics, and Real Time Kinematics (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.

Logistics Operations - The GCMRC provides complete logistical support for 35-40 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 Lees 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, and salaries.

### **GCMRC’S BIENNIAL 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 initial science symposium was convened at 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. For the first time in this draft work plan and budget, a line item is included in the budget for the estimated cost of planning and implementing the Science Symposium. These costs include: lease

of the meeting venue, duplication and technical support costs, as well as invitational travel and per diem associated with keynote speakers and other invited guests.

### **SCHEDULE AND BUDGET**

The development and approval process for the Annual Work plan of the GCD-AMP, including the GCMRC's science budget has been developed through the recommendations from the Budget ad hoc group of the Technical Workgroup. Typically, the schedule for development, review, revision and approval of the annual work plan for a single, out-year, is setup so as to identify a "bottom line" for the work plan and budget by about January, with approval of the detailed plan to follow in the spring during the AMWG's normally scheduled March meetings. Unfortunately, owing to the many pending planning activities, this schedule has been somewhat delayed in the past several years owing to the uncertainty associated with not having approved core-monitoring and research plans completed.

For the FY 2006 work plan and budget, additional uncertainties (and thereby, additional delays) have forced the development and approval process well into the summer of 2005. A future hope is that a two-year work plan and budget can start being developed at an earlier scheduled (presumably, this would start in summer 2005 for a combined FY 2007-08 work plan and budget) once major components of the Strategic Science Implementation Plan (SSIP) are finalized and approved by AMWG in the coming months.

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

### **Budget Review and Approval Process**

GCMRC recognizes the critical need for the Technical and Adaptive Management Workgroups to be involved in the science programming, planning and budget process. Following extensive discussions between the GCMRC staff and various ad hoc groups of the Technical Workgroup, a third revision of the work plan and budget has been prepared and distributed to the TWG members. The GCMRC will seek a motion from the TWG at its summer 2005 meeting, as a recommendation supporting the proposed activities described in the FY 2006, that will then be forwarded from the TWG to the AMWG during summer 2005. Ultimately, a final recommendation for implementation of the work plan will be sought by the TWG from the

AMWG at its August 2005 meeting in Phoenix, AZ and that recommendation will be forwarded to the Secretary's Designee and considered for approval by the Department of the Interior.

## CHAPTER 3

### SCIENCE ACTIVITIES

#### A. PHYSICAL SCIENCE, MODELING AND DASA PROGRAM

##### Project A.1. Ongoing Provisional Monitoring - Lake Powell Quality-of-Water

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 (17%)	0	36,000	32,000	31,000	31,820
Funding to GCMRC	265,000	237,000	210,000	210,000	215,250
Reclamation Assistance	35,000	114,000	*0	*0	?
<b>Project Total</b>	<b>300,000</b>	<b>351,000</b>	<b>210,000</b>	<b>210,000</b>	<b>218,994</b>
<b>% Total Outsourced</b>	<b>35%</b>	<b>10%</b>	<b>~12%</b>	<b>~14%</b>	<b>0%</b>

**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.

**Implications of Experimental vs. Non-Experimental Scenarios:** None here.

**Project A.2. – Ongoing Provisional Monitoring – Downstream 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	325,000
Logistics Field Support	40,000	40,000	152,000	160,000	25,000
Project Related Travel/Training	—	—	—	—	10,000
Operations/Supplies	235,500	130,500	142,500	190,000	30,000
GCMRC Salaries	81,000	162,000	195,000	330,000	309,100
Project Subtotal	—	—	—	—	699,100
DOI Customer Burden (17%)	—	—	—	—	118,847
<b>Project Total</b>	<b>685,500</b>	<b>808,500</b>	<b>1,104,000**</b>	<b>1,607,500**</b>	<b>817,947</b>
<b>% Total Outsourced</b>	<b>~51%</b>	<b>~61%</b>	<b>~63%</b>	<b>~63%</b>	<b>41%</b>

\* 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.

**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.

**Implications of Experimental vs. Non-Experimental Scenarios:** Even in the earlier draft workplan of February 2005, this project was limited in its scope to measurements made only between the forebay of the dam and river mile 87 (Grand Canyon gage near Phantom Ranch). Under the “With Experiment” scenario, there are reductions in several parts of the the budget that are required to support both: 1) the experimental treatments and Humpback chub actions and 2) the proposed carry-forward fund to support experimental work in FY 2007 and beyond. Under the “With Experiment” scenario, these reductions will force the GCMRC staff to undertake more of the field efforts required to obtain water quality samples and data in support of the suspended-sediment mass balance work to keep the project viable (meaning more need to coordinate and oversight student contractors, employees, administrative support, etc.). In the “Without Experiment” scenario, the project is basically restored to the funding levels under the original budget (shown in the February 2005 draft version) and most of this field effort would be undertaken by the Water Resources Discipline of the USGS (Arizona District personnel), albeit at a higher cost. More involvement by GCMRC staff in the “With Experiment” version of the work plan means that these scientists and technicians have less time to contribute to planning activities, as well as analyses and reporting. Reduction in the number of river-support trips for sampling and maintenance of the monitoring sites (from 6/yr down to 2/yr) will likely have the effect of increasing the measurement uncertainty associated with the reporting of fine-sediment inputs versus export.

**Project A.3. Completion of Research & Development in Support of Monitoring 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 (6%)	—	—	—	—	15,375
Project Total	511,000	442,000	860,000*	1,000,000*	271,625
% 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 final reporting year for this project, including results of the November 2004 High-Flow sediment test..

**Reports published to date:**

- Rubin, D.M., 2004, A simple autocorrelation algorithm for determining grain size from digital images of sediment: *Sedimentology*.
- NAU 2005 Fact Sheet.
- 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.
- Topping and others, 2004, High-resolution monitoring of suspended-sediment concentration and grain size in the Colorado River in Grand Canyon using a laser-acoustic system.
- Melis and other, 2003, Testing laser-based sensors for continuous *in situ* monitoring of suspended sediment in the Colorado River, Arizona.

**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.
- Reporting of the results of the November 2004 sediment experiment at the 2005 Science Symposium

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

**Implications of Experimental vs. Non-Experimental Scenarios:** None here, as there is no High-Flow Sediment Experimental treatment proposed. Funding is maintained at the originally proposed level so as to accomplish final reporting on the November 2004 sediment experiment.

**Project A.4. – Ongoing Support of Provisional Monitoring Remote Sensing Data Acquisition – DASA Coordinator (G. Bennett) and Remote Sensing Support (F.M. Gonzales)**

FUNDING HISTORY	Fiscal year				
	2003	2004	2005	2006	2007
<b>Outside GCMRC Science/Labor</b>	<b>82,500</b>	<b>123,000</b>	<b>170,000</b>	<b>0</b>	<b>85,500</b>
<b>Logistics Field Support</b>	<b>N/A</b>	<b>20,000</b>	<b>5,000</b>	<b>0</b>	<b>20,000</b>
<b>Project Related Training/Travel</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>5,000</b>
<b>Operations/Supplies</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>56,000</b>
<b>GCMRC Salaries</b>	<b>20,000</b>	<b>20,000</b>	<b>25,000</b>	<b>28,100</b>	<b>28,100</b>
<b>Project Subtotal</b>	<b>—</b>	<b>—</b>	<b>—</b>	<b>28,100</b>	<b>194,100</b>
<b>DOI Customer Burden (17%)</b>	<b>—</b>	<b>—</b>	<b>—</b>	<b>4,777</b>	<b>32,997</b>
<b>Project Total</b>	<b>102,500</b>	<b>163,000</b>	<b>200,000</b>	<b>32,877</b>	<b>227,097</b>
<b>% Total Outsourced</b>	<b>80%</b>	<b>82%</b>	<b>85%</b>	<b>0%</b>	<b>4%</b>

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 and Database Administrator (G. Bennett), 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 Estimated Costs for FY 2005 System-wide Overflights (including EXP)**

Year	Remote Sensing Component	Cost per km	Kilometers	Total Cost
	• Digital Multi-spectral Imagery	\$588	~480	\$242,500
	• Planning Support (Davis detail)			\$40,000
	• LiDAR (FIST Reaches only)	\$2,850	~35	\$100,000
	• Technical Costs & Labor			\$30,000
	• Data Storage (Eight Terabytes)			\$64,000
	• Reduced HydroRevenue (?days)			?
	• TOTAL PROJECT COST			\$476,500

**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 experimental and monitoring budget was able to support a system-wide digital overflight in support of the Experimental High-Flow Test for both sediment and terrestrial vegetation, the FY 2006 budget for this project is reduced to cover only one-third of salary of the GCMRC's Remote-Sensing Coordinator within the DASA. This strategy allows funds to be made available to support the FY 2006 (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 18 cm spatial resolution.
- Canyon-wide, panchromatic digital imagery at 18 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.

**Implications of Experimental vs. Non-Experimental Scenarios:** None here, as there is no High-Flow Sediment Experimental treatment proposed. Budget consists only of partial salary support for the GCMRC's Remote-Sensing Coordinator.

**Project A.5a. Science Support of All Data Storage within Grand Canyon Integrated (Oracle) Database Management System (DASA) – Database Administrator and DASA Coordinator (G. Bennett)**

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor	100,000	251,000	18,000	15,000	32,500
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	91,500
Project Subtotal	—	—	—	—	139,000
DOI Customer Burden (6 to 17%)	—	—	—	—	18,105
<b>Project Total</b>	<b>201,000</b>	<b>363,000</b>	<b>128,000</b>	<b>128,000</b>	<b>157,105</b>
<b>% Total Outsourced</b>	<b>50%</b>	<b>69%</b>	<b>~14%</b>	<b>~12%</b>	<b>21%</b>

**Principal Investigators:** DASA Coordinator and DBMS administrator (G. Bennett), 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 through a combination of internal staff expertise and a cooperative agreement with an Oracle database expert. 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.

FY04-06 – 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

**Implications of Experimental vs. Non-Experimental Scenarios:** None here, as there is no High-Flow Sediment Experimental treatment proposed.

**Project A.5b. Ongoing Data Conversion & Library Operations (DASA) – DASA Coordinator and DASA Librarian (G. Bennett and S. Wyse), U.S. Geological Survey**

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor	0	15,249	0	17,000 <sup>1</sup>	24,000 <sup>2</sup>
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	88,600 <sup>3</sup>
Project Subtotal	—	—	—	—	145,850
DOI Customer Burden (6 to 17%)	—	—	—	—	22,155
<b>Project Total</b>	<b>65,500</b>	<b>77,049</b>	<b>79,000</b>	<b>99,000</b>	<b>168,005</b>
<b>% Total Outsourced</b>	<b>0%</b>	<b>20%</b>	<b>0%</b>	<b>17%</b>	<b>14%</b>

<sup>1</sup>Student contractor funding for 2004 funded in 2003.

<sup>2</sup>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 Northern Arizona University and other services.

<sup>3</sup>This figure reflects the total salary of GCMRC GIS and Database support (formerly, the Librarian), as well as 1/3 of the Remote-Sensing Coordinator's salary to assist with analog-to-digital data conversion efforts.

**Principal Investigators:** S. Wyse – GCMRC and E. Quinn – Student 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 DASA scanning project will proceed on schedule, with an initial pilot study conducted to ascertain the appropriate steps required to proceed from data conversion (scanning process) to orthorectification and photogrammetry towards topographic analysis (change detection for sand bar volume and area within a sample study reach).

**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 addition, 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.

**Implications of Experimental vs. Non-Experimental Scenarios:** None here, as there is no High-Flow Sediment Experimental treatment proposed.

**Project A.6. Ongoing Support – GIS General Support for Integrated Analyses and Projects (DASA)**  
GIS Lead, (T. Gushue)

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor	8,000	8,000	0	0	18,200
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	122,500
Project Subtotal	—	—	—	—	160,700
DOI Customer Burden (15%)	—	—	—	—	25,315
<b>Project Total</b>	<b>149,000</b>	<b>130,000</b>	<b>80,000</b>	<b>80,000</b>	<b>186,017</b>
% Total Outsourced	5%	6%	0%	0%	10%

**Principal Investigator:** GIS Coordinator (T. Gushue), plus one GIS term appointment.

**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 project subcomponents are adjusted upward to cover support now provided by a cooperators (formerly covered by a third GIS staff member. The overall objective is provide a level of services similar to FY2003-04.

**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.

**Support for 2004 Experimental Analysis:** 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.

**Implications of Experimental vs. Non-Experimental Scenarios:** None here, as there is no High-Flow Sediment Experimental treatment proposed.

**Project A.7. Completion of Channel-Mapping Project (DASA) – Remote-Sensing Coordinator, (F.M Gonzales)**

FUNDING HISTORY	Fiscal year				
	2003	2004	2005	2006	
Outside GCMRC Science/Labor	—	—	—	—	—
Logistics Field Support	—	—	—	—	—
Project Related Training/Travel	—	—	—	—	—
Operations/Supplies	—	—	—	—	—
GCMRC Salaries	—	—	—	28,100	—
Project Subtotal	—	—	—	28,100	—
DOI Customer Burden (17%)	—	—	—	4,777	—
<b>Project Total</b>	—	—	—	<b>32,877</b>	—
<b>% Total Outsourced</b>	—	—	—	<b>0%</b>	—

**Summary Project Description:** This project is intended to provide full channel geometry map coverage of the portions of the main channel between Glen Canyon Dam and Phantom Ranch. The FY 2006 effort is intended to complete the channel mapping work that was initially started

in FY 2001. The remaining work mostly consists of a GIS efforts required to combine the terrestrial portion of the topographic data derived system-wide from the 2000 LiDAR overflight with the multi-beam bathymetric (aquatic) topographic data collected by the Remote-Sensing Coordinator.

**Project Goals and Objectives:** Once completed, these combined topographic channel models are used to support flow and sediment model simulations aimed at prediction of physical habitat conditions that evolve under differing scenarios of dam releases and fine-sediment supply conditions. These topographic models can also be used to determine changes in sediment storage in the main channel when repeat mapping is conducted for similar areas in the future (related to either experimental research or long-term monitoring).

**Implications of Experimental vs. Non-Experimental Scenarios:** None here, as there is no High-Flow Sediment Experimental treatment proposed. Budget consists only of partial salary support for the GCMRC's Remote-Sensing Coordinator.

## B. BIOSCIENCES

### Project B.1. Ongoing Provisional Monitoring – Terrestrial Activities (KAS and SWWF)

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor	10,000	30,000	21,000	22,000	35,000
Logistics Field Support	40,000	33,000	37,000	35,000	30,000
Project Related Travel/Training	—	—	—	—	—
Operations/Supplies	16,000	6,000	7,000	7,000	0
GCMRC Salaries	16,000	12,000	14,000	15,000	14,215
Project Subtotal	—	—	—	—	79,215
DOI Customer Burden (6 to 17%)	—	—	—	—	9,617
<b>Project Total</b>	<b>82,000</b>	<b>81,000</b>	<b>79,000</b>	<b>79,000</b>	<b>88,832</b>
<b>% Total Outsourced</b>	<b>48%</b>	<b>69%</b>	<b>64%</b>	<b>63%</b>	<b>56%</b>

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. 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.

**Implications of Experimental vs. Non-Experimental Budget:** Surveys for KAS will only occur once, in the fall in FY06.

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
- 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. A review of methodologies could take place in FY06, pending availability of funds and staff time. Exploring alternative methodologies will be delayed under this schedule until funds are available.

**Budget Changes:** *Outside Science/labor:* Allocation is reduced by \$20,000 and KAS surveys are conducted once in the fall (August/September) of 2006. *Logistics:* logistics is reduced by \$10,000, the cost of a trip. *Training/travel related costs:* reduced to zero. *GCMRC salaries:* Reduced to cover 1/7<sup>th</sup> of terrestrial biologist time.

**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. Continued Research and Development – Aquatic Productivity, Organic Mass Balance, and Food Web Linkage Studies**

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor	N/A	N/A	160,000	220,000	100,000
Logistics Field Support	N/A	N/A	40,000	40,000	50,000
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	109,015
Project Subtotal	—	—	—	—	264,015
DOI Customer Burden (6 to 17%)	—	—	—	—	35,055
Project Total	N/A	N/A	248,000	315,000	299,070
% Total Outsourced	N/A	N/A	~79%	~81%	42%

**Principal Investigators:** Kennedy (USGS/GCMRC) 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 autochthonous 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;

**Status/Schedule:** Project scheduled for implementation in FY06 and to continue through FY08.

**Implications of Experimental vs. Non-Experimental Budget: *Outside Science/labor:***

Allocation is reduced by \$100,000 as recommended by BAHG for either budget scenario. The bulk of funding for FY06 is coming from FY05 obligation that is to occur in August 2005. This budget item will be restored to at least \$200,000 in FY07 & FY08 to ensure success and completion of this initiative. *Logistics:* logistics is reduced by \$35,000 in the with experiment scenario, this is essentially the cost of a motorized or 2 oar trips depending on equipment personnel needs. In the non-experimental budget scenario, logistics is restored to 85,000 levels. *Training/travel related costs:* not changed. *GCMRC salaries:* Includes aquatic biologist salary and 1/7<sup>th</sup> of terrestrial biologist time that will provide support for this cooperative effort.

**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. Ongoing Provisional Monitoring – Status and Trends of Downstream Fish Community**

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
<b>Outside GCMRC Science/Labor</b>	<b>469,000</b>	<b>570,000</b>	<b>596,000</b>	<b>546,000</b>	<b>550,000</b>
<b>Logistics Field Support</b>	<b>176,000</b>	<b>153,000</b>	<b>150,000</b>	<b>150,000</b>	<b>125,000</b>
<b>Project Related Travel/Training</b>	—	—	—	—	<b>5,000</b>
<b>Operations/Supplies</b>	<b>0</b>	<b>15,000</b>	<b>30,000</b>	<b>30,000</b>	<b>20,000</b>
<b>GCMRC Salaries</b>	<b>28,000</b>	<b>71,000</b>	<b>94,000</b>	<b>94,000</b>	<b>135,465</b>
<b>Project Subtotal</b>	—	—	—	—	<b>835,465</b>
<b>DOI Customer Burden (6 to 17%)</b>	—	—	—	—	<b>82,379</b>
<b>Project Total</b>	<b>673,000</b>	<b>809,000</b>	<b>870,000</b>	<b>820,000</b>	<b>917,844</b>
<b>% Total Outsourced</b>	<b>92%</b>	<b>88%</b>	<b>84%</b>	<b>83%</b>	<b>68%</b>

**Principal Investigators:** Coggins, and technician, U.S. Geological Survey, (GCMRC), 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.

**MO's and CMIN'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.

**Status/Schedule:** This is on-going work associated with monitoring development and evaluation. The LCR component will undergo review in FY06.

**Implications of Experimental vs. Non-Experimental Budget:** *Outside Science/labor:* Allocation is unchanged, but still remains below FY04 funding levels. *Logistics:* logistics is reduced by \$5,000. In the non-experimental budget scenario, logistics is restored to 130,000 levels. *Training/travel related costs:* not changed. *Operations/supplies:* remains unchanged for

each budget. *GCMRC salaries*: Includes 100% fishery biologist salary, 50% fishery technician and 14% of terrestrial biologist time for agreement coordination.

**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. Ongoing Provisional 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	20,000	20,000	10,000	8,000
Project Related Travel/Training	—	—	—	—
Operations/Supplies	10,000	16,000	10,000	—
GCMRC Salaries	18,000	9,000	11,000	44,215
Project Subtotal	—	—	—	142,215
DOI Customer Burden (6 to 17%)	—	—	—	14,277
<b>Project Total</b>	<b>138,000</b>	<b>161,000</b>	<b>111,000</b>	<b>156,492</b>
<b>% Total Outsourced</b>	<b>78%</b>	<b>83%</b>	<b>85%</b>	<b>60%</b>

**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 in FY06. This project is one of the core monitoring projects identified in the provisional core monitoring plan and will undergo review in FY06. An RFP would be released for subsequent funding years.

**Implications of Experimental vs. Non-Experimental Budget:** *Outside Science/labor:* Allocation is unchanged. *Logistics:* logistics is reduced by \$2,000 in both scenarios. *Training/travel related costs:* reduced to zero. *Supplies/operations:* reduced to zero with equipment costs absorbed by downstream fish monitoring. *GCMRC salaries:* 50% of fish technician salary and 14% of terrestrial biologist time for agreement coordination.

**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)

**Formerly B.5 “Concurrent Estimates of Humpback Chub”-Note: This project is deferred to FY07.**

**Project B.5. Completion of Habitat Map & Inventory in Support of Monitoring**

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor	—	—	—	—	—
Logistics Field Support	—	—	—	—	—
Project Related Travel/Training	—	—	—	—	—
Operations/Supplies					
GCMRC Salaries	—	—	—	—	14,215
<b>Project Subtotal</b>	—	—	—	—	<b>14,215</b>
DOI Customer Burden (6 to 17%)	—	—	—	—	2,417
<b>Project Total</b>		<b>70,650</b>	<b>88,000</b>	—	<b>16,632</b>
<b>% Total Outsourced</b>	<b>92%</b>	<b>88%</b>	<b>84%</b>	<b>0%</b>	<b>0%</b>

**Principle Investigators:** B. Ralston, GCMRC/USGS, P. Davis USGS.

**Statement of Problem:** This project addresses recommendations made in the terrestrial, cultural resource, and sediment protocol review reports. Terrestrial mapping of the Colorado River corridor is required for spatial monitoring of physical, biological, and cultural resources. Terrestrial mapping usually produces a digital terrain model (DTM) in combination with the XYZ position of features and artifacts. Periodic mapping of the same areas can be used for change detection of resources. Attributes associated with a coverage type can also be used as a predictive tool for monitoring and research.

**Project Summary:** This project is intended to measure, record and map terrestrial habitat throughout the river ecosystem. These data will be related to available habitat relative to annual

operations of Glen Canyon Dam and compared with change since 1992, and earlier years as permissible with existing data. Specific objectives of the project include:

- Provide a baseline of vegetated and open terrestrial habitat that can be used for long-term, community-based change detection.
- To provide a vegetation map of the river corridor that uses a uniform hierarchical vegetation classification system that is compatible with NPS park units and AMP program purposes.
- The vegetation data will be compared with historic aerial photographs to detect and study changes.

**MO's Addressed:** This project addresses MO's under Goal 6 including 6.1, 6.2, 6.3., 6.4., and 6.5.

**Status/Schedule:** This project should be completed and through the review process by December 2005. The budget covers 14% of the terrestrial biologist's salary to complete the reports and finalize the coverage.

**Implications of Experimental vs. Non-Experimental Budget:** *Outside Science/labor:* Allocation is unchanged. *Logistics:* unchanged. *Training/travel related costs:* unchanged. *Supplies/operations:* unchanged. *GCMRC salaries:* 14% of terrestrial biologist time to complete project..

**Expected Products/Deliverables:**

- Completion of vegetation coverage for GIS network.
- Randomized sampling design for terrestrial resource survey.

**Integration:** To achieve ecosystem-level scientific understanding of the relationships between resources of the CRE and Glen Canyon Dam operations, integration of long-term monitoring between physical, cultural, biological, and recreational resources is required. The inventory and mapping of system-wide vegetation communities provides information about changes in open and vegetated areas (camping beaches) and changes in the old and new high water vegetative communities as a whole (e.g., how have marsh community areas changed since 1992?). The primary goal for this project is to document compositional and area coverage changes at a reach based or landscape scale every 5 years to complement field based surveys that occur at a finer scale every year.

**Project B.6. Completion of Experimental Treatment – Spawning Redds and Suppression Mechanisms**

FUNDING HISTORY	Fiscal year			
	2003	2004	2005	2006
<b>Outside GCMRC Science/Labor</b>	—	145,000	—	100,000
<b>Logistics Field Support</b>	—	20,000	—	30,000
<b>Project Related Travel/Training</b>	—	—	—	—
<b>Operations/Supplies</b>	—	—	—	—
<b>GCMRC Salaries</b>	—	—	—	14,215
<b>Project Subtotal</b>	—	—	—	144,215
<b>DOI Customer Burden (6 to 17%)</b>	—	10,000	—	13,517
<b>Project Total</b>	—	175,000	—	157,732
<b>% Total Outsourced</b>	—	88%	0	73%

**Principal Investigators:** L. Coggins, U.S. Geological Survey (GCMRC), and J. Korman, Ecometric Research Inc.

**Statement of Problem:** Experimental flows from 2003 – 2005 targeted survival rate of young rainbow trout through increased daily fluctuations in flow from January through March. A study was conducted during this period to measure the impact of the flows on the early life stages of rainbow trout below Glen Canyon Dam. The study measured timing and distribution of redd excavation across elevations, quantified spawning habitat preferences with depth, velocity and substrate relative to changes in discharge, estimated trends in trout fry recruitment and survival in Glen Canyon, and lastly surveyed for redd and fry in the mainstem below Lees Ferry to the Little Colorado River confluence to evaluate natural reproduction in the mainstem. The results and conclusions provide testable hypotheses around these four objectives with the prospect of returning to previous MLFF operations.

**Project Summary:** This project would follow-up on data collection initiated under experimental flows to determine how MLFF operations affect survival rates of young rainbow trout below Glen Canyon Dam. The specifics of the project are still in the development phase.

MO's and RINs addressed: 4.2.

**Status/schedule:** This project would begin in FY06 and be completed in FY07.

**Implications of Experimental vs. Non-Experimental Budget:** *Outside Science/labor:*

Reduced from previous effort to \$100,000 *Logistics:* 30,000 for downstream work support.

*Training/travel related costs:* zero *Supplies/operations:* zero. *GCMRC salaries:* 14% of terrestrial biologist time to assist with coordination. Under the "Non-Experimental" scenario, this project would not be funded.

**Expected Products/Deliverables:**

Draft and final report

Possible peer reviewed manuscript

**Project B.7. Completion of Experimental Treatment – 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	44,215
Project Subtotal	N/A	—	—	—	702,215
DOI Customer Burden (6 to 17%)	N/A	—	—	—	92,977
<b>Project Total</b>	N/A	<b>586,000</b>	<b>586,000</b>	<b>586,000</b>	<b>795,192**</b>
<b>% Total Outsourced</b>	N/A	<b>54%</b>	<b>54%</b>	<b>59%</b>	<b>56%</b>

\*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.

**Status/Schedule:** First and second-year field efforts completed. Draft report covering three year efforts in preparation. Planning for subsequent final year is underway.

**Implications of Experimental vs. Non-Experimental Budget:** *Outside Science/labor:* Allocation is increased to meet true costs of project. *Logistics:* increased to meet true costs of project. *Training/travel related costs:* unchanged. *Supplies/operations:* absorbed by downstream fish project. *GCMRC salaries:* Student aide position to assist with trip prep/repair,

14% of terrestrial biologist time to assist with agreement coordination. Under the “Non-Experimental” scenario, this project would end in FY 2005.

**Expected Products/Deliverables:**

- Biannual 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 FY02 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.8. Ongoing Humpback Chub Action – Translocation of Humpback Chub**

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
<b>Outsourced Science/Labor</b>	N/A	10,000	10,000	46,000	45,000
<b>Logistics</b>	N/A	15,000	15,000	0	5,000
<b>Operations</b>	N/A	0	0	0	0
<b>Salary</b>	N/A	0	0	0	0
<b>Project Subtotal</b>	N/A	—	—	47170	50,000
<b>DOI Customer Burden (6 to 17%)</b>	N/A	—	—	2830	3,550
<b>Project Total</b>	N/A	25,000	25,000	50,000	53,550
<b>% total outsourced</b>	N/A	~70%	~70%	~94%	100%

**Principal Investigators:** U.S. Fish & Wildlife Service

**Statement of Problem:** As identified by the AMWG ad hoc committee on humpback chub and the December 2002 USFWS Biological Opinion, the first phase of this project is aimed at increasing the survival and expanding the geographic range of humpback chub in the LCR. The first phase of this effort will be completed by the delivery of a report in December 2005. With the existence of these additional fish above established monitoring sites for the LCR comes the

issue of adding these fish to the monitoring efforts and how much this additional effort will affect monitoring budgets and overall program budgets. The second phase addresses identifying other tributaries where translocation of humpback chub and other native fishes would be appropriate. The identification of other tributaries, development of an appropriate translocation plan, monitoring and funding source for this effort would be included in this phase. This effort would be coordinated with the National Park Service.

**Summary Project Description:** Phase 1 initiated in 2003 by USFWS with translocation of juvenile humpback chub to the upper reaches of the perennial flowing LCR with follow-up monitoring. Funds for this work include continued data collection at the translocation site in the LCR and time for additional translocation events, if appropriate. If phase 2 of this project is to proceed, we recommend preparing an RFP for initiation in 2007. Award of project funding will be contingent on rigorous scientific review of project proposal.

**MO's and RIN's ADDRESSED:** MO 2.1 and 2.6

**Status/Schedule:** This project will be completed in December 2005 with the delivery of a final report.

**Implications of Experimental vs. Non-Experimental Budget:** *Outside Science/labor:* Allocation is increased to cover monitoring and translocation. *Logistics:* unchanged. *Training/travel related costs:* zero. *Supplies/operations:* zero. *GCMRC salaries:* zero.

**Expected Products/Deliverables:**

- Annual and final reports.

### Project B.9. Completion of Humpback Chub Action – Dam Operations Experiment

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor	N/A	N/A	20,000	20,000	15,000
Logistics Field Support	N/A	N/A	---	---	---
Project Related Travel/Training	N/A	N/A	27,000	36,000	10,000
Operations/Supplies	N/A	N/A	---	---	---
GCMRC Salary	N/A	N/A	---	---	---
Project Subtotal	N/A	N/A	—	—	25,000
DOI Customer Burden (6 to 17%)	N/A	N/A	3,000	3,000	2,600
Project Total	N/A	N/A	50,000	50,000	27,600
% Total Outsourced	N/A	N/A	54%	59%	90%

**Principal Investigators:** U.S. Geological Survey (GCMRC), stakeholders, science cooperators

**Statement of Problem:** The Glen Canyon Dam Adaptive Management Program is charged with implementing experiments to better understand the linkages between operation of Glen Canyon Dam and other experimental manipulations and resources for which management goals and objectives have been established. Experimental planning is a crucial element in this process. With the approval of the 2003-2004 recommended experimental treatments, the GCDAMP has begun long-term experimental planning. However, adequate time and resources must be made available to continue this process.

**Summary Project Description:** We propose to use the funds identified in this project to continue the planning process for experimentation during 2006. This will be accomplished in part by convening a workshop for GCDAMP participants in the fall and spring of 2005/2006. This workshop will utilize the multi-attribute trade off analysis begun earlier this year. Expected results of the workshop will include recommendations for future year experiments. This project will also fund additional GCMRC staff to develop RFP's associated with GCMRC sponsored activities related to core monitoring, experimental treatments, new research initiatives, and AMWG ad hoc humpback chub committee recommendations.

**MO's and RIN's ADDRESSED:** Goal 2 and MO 2.1 - 2.5

**Status/Schedule:** Yet to be determined.

**Implications of Experimental vs. Non-Experimental Budget:** *Outside Science/labor:*

Allocation is decreased to \$15,000 *Logistics:* zero. *Training/travel related costs:* changed to \$10,000 to cover travel associated with planning. *Supplies/operations:* zero. *GCMRC salaries:* zero.

**Expected Products/Deliverables:**

- Long term experimental plan

**Experimental Component:** (supports long-term experimental planning and Multi-Attribute Trade-off and Risk Assessments (MATA workshops and other related experimental planning activities)

**Project B.10. Completion of Humpback Chub Action – Monitoring Fish Disease and Parasites in the Colorado River Ecosystem**

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
<b>Outsourced Science/Labor</b>	N/A	N/A	50,000	55,000	0
<b>Logistics</b>	N/A	N/A	0	0	20,000
<b>Operations</b>	N/A	N/A	0	0	0
<b>Salary</b>	N/A	N/A	0	0	0
<b>Project Subtotal</b>	N/A	N/A	42,500	51,700	20,000
<b>DOI Customer Burden (6 to 17%)</b>	N/A	N/A	7,500	3,300	3,400
<b>Project Total</b>	N/A	N/A	50,000	55,000	23,400
<b>% total outsourced</b>	N/A	N/A	~88%	~94%	~43%

**Principal Investigators:** R. Cole, U.S.G.S and B. Persons, Arizona Game and Fish Dept.

**Statement of Problem:** With the advent of increased river warming as reservoir water levels fall and particularly with the operation of a temperature control devise, increased fish disease and parasitism may occur. As potential disease could represent a significant mortality threat to fishes

within the CRE, it is important not only to monitor the future incidence of parasitism and disease, but to document a baseline condition before initiation of TCD.

**Summary Project Description:** A survey of the parasites of fish of the Colorado River and selected tributaries will be conducted over an 18-20 day period in June-July 2006. Fish will be collected by AZGD fish biologists using a combination of electroshocking (boat and backpack), seining, minnow trapping, trammel netting and hoop netting. Fish will be collected by AZGD fish biologists and necropsied by parasitologists from the National Wildlife Health Center (NWHC), Madison WI on site. Approximately 10-15 fish of each species will be necropsied at each collection point. Parasite samples collected will be preserved and transported back to the NWHC for identification and enumeration. Aquatic invertebrate samples at each sample site will be collected to assess the ability of intermediate hosts to spread into the mainstem as water temperature increases. We will especially monitor the presence/absence of the New Zealand mudsnail *Potamopyrgus antipodarum* (Gray). After the initial survey, the investigators will design a program to monitor changes in the parasite community over time. It is estimated that a field survey trip of smaller magnitude would be encouraged every 5-7 years.

**MO's and RIN's ADDRESSED:** Goal 2: M.O. 2.5

**Status/Schedule:** This project will begin in late FY05 and ends in FY07.

**Implications of Experimental vs. Non-Experimental Budget:** *Outside Science/labor:* Project was funded in FY05. *Logistics:* 20,000 to support project trip. *Training/travel related costs:* zero. *Supplies/operations:* zero. *GCMRC salaries:* zero.

**Expected Products/Deliverables:**

- Annual and Final Reports
- Monitoring recommendations

**Experimental Component:** (Related to implementation and testing the TCD proposed for Glen Canyon Dam)

**Integration:** (Downstream elements of the IQWP, such as temperature and relationship to pathogens and parasites in the main channel – influence on fisheries and food base)

**Project B.11. Completion of Humpback Chub Action – Temperature Control Device**

FUNDING HISTORY	Fiscal year				
	2001	2002	2004	2005	2006
<b>Outsourced Science/Labor</b>	N/A	N/A	105,000	104,187	188,680
<b>Logistics</b>	N/A	N/A	20,000	13,000	—
<b>Operations</b>	N/A	N/A	25,000	43,080	—
<b>Salary</b>	N/A	N/A	50,000	16,430	—
<b>Project Subtotal</b>	N/A	N/A		176,679	188,680
<b>DOI Customer Burden (6%)</b>	N/A	N/A		17,772	11,320
<b>Project Total</b>	N/A	N/A	200,000	194,451	200,000
<b>% total outsourced</b>	N/A	N/A	~60%	~90%	100%

**Principal Investigators:** To be determined

**Statement of Problem:** A possible benefit to elevated release temperatures from Glen Canyon Dam associated with a temperature control device is an increase in mainstem and nearshore water temperature. These nearshore environments can serve as rearing habitat utilized by native fishes. In addition to monitoring water temperature, it may also be important to monitor use of these potential rearing habitats by native and non-native fishes.

**Summary Project Description:** The BuRec allocated \$200,000 per year in FY 2004 and FY 2005 and possibly in FY 2006 to complete final compliance for the TCD as well as support baseline monitoring of nearshore habitats prior to implementation of the TCD. We recommend that whatever portion of these funds that are available following compliance be used to fund a project to monitor key nearshore habitats near the Little Colorado River for both warming and fish utilization. The BuRec has oversight on the funds and their allocation.

**Implications of Experimental vs. Non-Experimental Budget:** *Outside Science/labor:* 186,000 subject to appropriated funds being available. *Logistics:* undermined. *Training/travel related costs:* N/A. *Supplies/operations:* undetermined. *GCMRC salaries:* undetermined.

## C. CULTURAL RESOURCES

### Project C.1. Ongoing Provisional Monitoring of Integrated Archaeological Sites

FUNDING HISTORY	Fiscal year			
	2003	2004	2005	2006
Outside GCMRC Science/Labor	—	—	17,500	234,420
Logistics Field Support	—	—	15,000	70,000
Project Related Travel/Training	—	—	—	—
Operations/Supplies	—	—	—	5,000
GCMRC Salaries	—	—	7,500	32,450
<b>Project Subtotal</b>	—	—	<b>40,000</b>	<b>341,870</b>
DOI Customer Burden (6 to 17%)	—	—	—	32,331
<b>Project Total</b>	—	—	—	<b>374,201</b>
<b>% Total Outsourced</b>	—	—	<b>63%</b>	<b>72%</b>

**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 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.

**Implications of Experimental vs. Non-Experimental Budget:** None.

**Project C.2. Synthesize Tribal Monitoring Programs Results (1995-2005)**

FUNDING HISTORY	Fiscal year			
	2003	2004	2005	2006
Outside GCMRC Science/labor	—	—	—	50,000
Logistics Field Support	—	—	—	—
Project Related Travel/Training	—	—	—	—
Operations/Supplies	—	—	—	—
GCMRC Salary (student intern)	—	—	—	25,000
<b>Project Subtotal</b>	—	—	—	<b>75,000</b>
DOI Customer Burden (6 to 17%)	—	—	—	7,250
<b>Project Total</b>	—	—	—	<b>82,250</b>
<b>% Total Outsourced</b>	—	—	—	<b>61%</b>

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 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 value specific locations (geologic landmarks, springs, shrines), biological resources (specific plants and animals), and minerals in the Colorado River Ecosystem that are 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. 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 used 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 Nations' histories and spiritual lives.

Since the mid 1990s, three of the five tribal entities participating in the GCD-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 GCD-AMP. Methods are highly variable between the various programs, as one would expect given the diverse cultural backgrounds and interests of the Tribes involved in the AMP.

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 TEM meetings, and representatives from Hopi and the Southern Paiute Consortium 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 not be met through the TEM program as currently designed, because the resources of interest to them are tied to specific, culturally important locations in the river

corridor, while the TEM program relies on a randomly selected sample of study sites, none of which overlap with specific locations of interest to the Tribes.

Currently, three of five tribal entities engaged in the GCD-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, plant and mineral resources. In April, 2005, representatives from these three tribes met with staff from GCMRC and NAU's Center for Sustainable Environments over the course of a three day workshop to articulate the goals and objectives of current tribal monitoring programs and receive feedback on how to align tribal monitoring objectives more closely with those the GCD-AMP. One outcome of the workshop was a recounting of the history of tribal monitoring within the GCD-AMP, and the processes and internal deliberations that led to the current configuration of the various tribal monitoring programs. In FY06, GCMRC will continue to work with the Tribes to implement workshop results and modify current protocols necessary to meet the specific needs of the GCD-AMP. As a step in this direction, the following proposed project will result in three synthetic reports, one from each of the tribes (Hopi, Hualapai, and Southern Paiute) currently engaged in actively monitoring resources in the CRE. The reports will summarize the results of tribal monitoring conducted since completion of the GCD-EIS and provide the GCD-AMP with a formal assessment of resource conditions from individual tribes' perspectives, based on the past ten years of tribal monitoring work in the CRE.

### **Management Objectives Re: Monitoring TCPs and other Tribally Valued Resources**

<b>MO #</b>	<b>Objective</b>
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 GCD-AMP compliance with GCPA.
11.2	Preserve resource integrity and cultural values of traditionally important resources within the Colorado River Ecosystem.
<b>CMIN #</b>	<b>Question</b>
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:** At a workshop sponsored by GCMRC in April 2005, tribal representatives from Hopi, Hualapai and the Southern Paiute Consortium collaborated with facilitators from Northern Arizona University's Center for Sustainable Environments to assess their current monitoring programs in terms of their relevance to GCPA and the GCD-AMP goals, as well as their relevance for meeting tribal information needs. (Representatives from the Navajo Nation and Pueblo of Zuni were asked to participate in this workshop also but were unable to do so.) The participating Tribes were asked to articulate rationales for using specific approaches and methodologies, as well as define the resource values that they consider important to monitor and preserve. The tribes did so by describing their chosen approaches to monitoring in terms of both traditional cultural perspectives, as well as in relation to the perceived changing needs and directions received from the BOR, PA, and GCD-AMP over the past ten years.

In FY06, as a foundational step towards developing a long term plan for monitoring tribal interests in the CRE, the tribes that are actively monitoring resources in the CRE will produce synthetic reports describing the history of their respective monitoring programs, the methodologies employed, information needs satisfied (both Tribal needs for information, as well as information needs identified in the AMP Strategic Plan) and summarizing the results of their monitoring work over the past ten years. These synthetic reports will serve a function similar to the SCORE Report, but will reflect the values and issues of principal concern to each individual Tribe. These synthetic reports will summarize baseline condition information and current trends in tribally valued resources to serve as the foundation for future tribal monitoring programs.

**Expected Products:**

- 1) Comprehensive synthesis of monitoring work conducted by each tribe since 1995 (one report from each of the three tribal entities actively engaged in monitoring CRE resources), including a complete history of monitoring work conducted by each tribe in the CRE, methods used, results

obtained, and recommendations for future management of Glen Canyon Dam and the CRE based on the past ten years of monitoring work.

2) Formal presentations to TWG and AMWG in the summer of 2006, presenting a synopsis of the final synthetic report, summarizing monitoring results, and providing recommendations to TWG and AMWG based on those monitoring results.

### **Project C.3. Integrated Campsite Monitoring and Research (Pilot Study)**

<b>FUNDING HISTORY</b>	<b>Fiscal year</b>				
	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>
<b>Outside GCMRC Science/Labor</b>	—	—	—	—	<b>50,000</b>
<b>Logistics Field Support &amp; MPS</b>	—	—	—	—	<b>15,000</b>
<b>Project Related Travel/Training</b>	—	—	—	—	<b>0</b>
<b>Operations/Supplies</b>	—	—	—	—	<b>6,000</b>
<b>GCMRC Salaries</b>	—	—	—	—	<b>7,450</b>
<b>Project Subtotal</b>	—	—	—	—	<b>78,450</b>
<b>DOI Customer Burden (6 to 17%)</b>	—	—	—	—	<b>7,837</b>
<b>Project Total</b>	—	—	—	—	<b>86,287</b>
<b>% Total Outsourced</b>	—	—	—	—	<b>67%</b>

**Principal Investigators:** Rod Parnell and associates, Northern Arizona University and Jack Schmidt and associates, Utah State University

**Statement of Problem:** Camp sites in the CRE are diminishing in size, quality and overall number under current dam operations (Kaplinski et al., 2003, 2005; NPS, 2004.) 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 may negatively impact 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 amount of shade-producing vegetation (Stewart et al., 2000) are directly influenced by dam operations.

The relationship between operations of Glen Canyon Dam and camping opportunities in the river corridor has been studied sporadically 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., 2005; 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, at a rate of approximately 15% per year since 1998 (Kaplinski et al., 2005.)

Reductions in camp site area and numbers are due to a combination of factors, including sediment being removed from the system by dam operations, sediment being removed by tributary floods (and not subsequently replaced by flood flows), and vegetation encroachment (Kaplinski et al., 2005.)

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, 2005).

The National Park Service currently monitors approximately 100 campsites for visitor use 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 GCD-AMP currently does not have a well conceived, integrated GCD-AMP 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 list of available camps, there is need for a ground-truthed record of current camp areas, so that changes in campable area, vegetation growth, and related-social impacts can be tracked and measured remotely over time.

**Summary Project Description:** The FY06 campsite monitoring program is designed to continue tracking and quantifying trends in the size, distribution, and physical qualities of selected campsites in the CRE (camps associated with the existing NAU sand bar series), while transitioning towards the use of remotely sensed imagery in evaluating changes to campable area and other important campsite attributes over time. The project proposed for FY06 will build on the current campsite area survey program (Kaplinski et al. 2005) and integrate it with complementary data derived from remotely sensed vegetation and sediment (digital imagery) data. The comparability of the two data sets will be systematically evaluated using GIS analytical techniques. In addition, if additional funding becomes available, the long-term photographic record produced by the Grand Canyon River Guides Adopt-a-beach program will be continued in order 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, if funding permits, we will begin the process of developing a comprehensive inventory (geo-referenced maps) of current camping areas and transferring these maps to a GIS, to serve as the foundation for future monitoring of system-wide changes in

campsite size, distribution and quality through time. GCMRC and NPS recreation management staff will collaborate in the proposed inventory effort, with NPS staff defining the campsite boundaries from a management perspective (i.e., NPS staff will define what they consider to be the acceptable boundaries of each camp).

The project includes the following interrelated components, which are listed in the order they will be implemented, subject to available funding. At the current level of funding proposed for FY06, only Items 1 and 2 will be fully funded in FY06.

- 1) The current program of repeat mapping of campable area at a judgmental sample of 45 sand bar camps will continue, while we transition to using more remotely sensed data. In addition, campable area changes in relation to overall changes in sand bar topography will be analyzed and quantified to assist in determining the specific factors responsible for campable area decline.
- 2) We will compare campable area at currently used camp sites with campable area polygons derived from GIS 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 camp attributes at a variety of camp types through time.
- 3) If additional funding is available in FY06, we will continue to support the Grand Canyon River Guides in gathering and archiving a long-term visual record of campsite changes using volunteer labor provided through the Grand Canyon River Guides' Adopt-A-Beach program.
- 4) If additional funding is available in FY06, 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.
- 5) If additional funding is available in FY06, we will begin the process of comprehensively inventorying all campsites currently used by river runners in the river corridor. Existing camp site inventory data (which is somewhat out of date) will be updated 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. These data will be combined with past and current NPS assessments of the maximum group size considered appropriate for each identified campsite. Each campsite will be mapped in the field with NPS collaborators in order to define current camp site area and boundaries, using orthorectified aerial imagery and the pen tablet approach recommended by Kaplinski et al. (2003). Important attributes of camp sites will be coded in linked data fields (e.g., type of camp, numbers of tent sites, boat mooring characteristics, etc).
- 6) If additional funding is available in FY06, we will compare currently used camp sites with formerly identified sites to determine changes in type, distribution, and (where possible) size and capacity of camp sites over the past thirty years.
  - 7) If additional funding is available in FY06, we will track and quantify amounts and rates of vegetation encroachment within the designated campsite boundaries. 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). Vegetation encroachment will be measured via repeat comparisons of remotely sensed, digital imagery.

**MO's and IN's ADDRESSED:** Goal 9. This project directly addresses MO 9.3 and CMINs 9.3.1 and 9.3.2, plus EIN 9.3.1. The project indirectly addresses MOs 9.1 and 9.4 and CMINs 9.1.1, 9.1.2, 9.1.3 and 9.4.1 (because diminishing size, quality and number of camps influences the quality of visitor experience through affecting perceptions of crowding, numbers of group encounters, and by increasing camp competition.)

**Consequences of FY06 Funding Recommendations:** The funding level currently proposed by the Budget Ad Hoc Group for FY06 is only sufficient to continue the existing campable area monitoring effort and conduct a preliminary GIS-based analysis of the current approach relative to an alternative, remotely sensed approach. The proposed funding level is not sufficient to compile a comprehensive inventory of campsites, as has been recommended in by previous studies (e.g. Kaplinski et al. 2003), nor is sufficient to continue funding the Adopt-A-Beach effort, or incorporate legacy data into a GIS to provide a more comprehensive and longer-term

record of campsite area change over time. If additional funding becomes available in FY06, additional components of the campsite monitoring program will be implemented.

**Status/Schedule: FY06-09:** FY06 represents the start up year of a multi-year effort to evaluate changes in campable area and other campsite attributes that are important to the maintaining a high quality recreational experience in the CRE. The first year will emphasize continuation of existing campable area measurements while simultaneously evaluating the appropriateness of using remotely sensed data as a proxy measure of campable area change and refining methods for calculating sand area and vegetation change. If additional funding becomes available, we will embark on inventorying current campsites and compiling baseline campsite data. Collection of system-wide digital imagery will occur in May 2005 as a follow up to the November 2004 experimental high flow; analysis of this digital data set will continue through FY09. This project builds upon and integrates the previous work of Kaplinski et al. (2003), Kaplinski et al. (2005) Breedlove (2003), and the ongoing Adopt-A-Beach effort.

**Expected Products/Deliverables:** In FY06, surveyors will continue the current program of mapping campable areas at selected campsites throughout the CRE, and these data will be analyzed and compared with polygons generated through remotely sensed data and GIS technology to systematically evaluate the comparability and reliability of these two different approaches. Two reports will be generated, one comparing changes in the surveyed campable area from October 2003 through October 2006, and evaluating campable area change in relation to sand bar topographic changes; a second report will evaluate the surveyed data in relation to campable area polygons produced via remote sensing and GIS analysis.

If additional funding becomes available in FY06, in addition to the above products, 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) a comprehensive inventory of potentially campable sand areas (based on remote sensing analysis); and 4) vegetation change within delineated camp sites will be produced. With additional funding, a thorough GIS-based analysis of these data would be conducted to 1) document changes in type, distribution and size of camp sites over time, and 2) document encroachment of vegetation on campable areas. The GIS data would be complemented by the

long-term visual (photographic) record of campsite changes derived from the ongoing Adopt-A-Beach Program.

**Integration:** This project proposes to integrate the monitoring of sand bar area and topography, monitoring of vegetation changes, and the long-term visual record of repeat photographs to create foundational elements for a long-term integrated campsite monitoring program. This project will also (eventually) integrate remotely sensed data with legacy campsite data derived from conventional aerial photos into a GIS. This project lays a foundation and builds capacity to link the changing physical attributes of camp sites currently affected by dam operations to the experiential parameters of visitor use values.

## D. LOGISTICS SUPPORT SERVICES PROGRAM

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

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
<b>Operations/Supplies (direct funded)</b>	—	—	—	—	42,000
<b>GCMRC Salaries (direct funded)</b>	98,300	121,000	121,000	125,000	62,800
<b>Direct Funded Subtotal</b>	—	—	—	—	104,800
<b>DOI 17% Customer Burden</b>	—	—	—	—	17,816
<b>Direct Funded Total</b>	—	—	—	—	122,616
<b>Outside GCMRC Science/Labor (See project Budgets)</b>	537,000	402,000	406,000	444,000	—
<b>NPS Permit Processing</b>	57,000	72,000	76,000	97,000	— <sup>4</sup>
<b>Outside GCMRC Subtotal (Shown in Individual Project Budgets)</b>	—	—	—	—	—
<b>Operations/Supplies (Project Funded)</b>	70,000	210,000	222,000	240,000	—
<b>Project Total</b>	762,300	805,000	825,000	906,000	122,616
<b>% Total Outsourced</b>	78%	59%	58%	60%	0%

Notes: <sup>1</sup>Project Funded dollars are deducted from applicable projects where the burden has been calculated. They previously been shown here to demonstrate the proportion of work that is completed by non-GCMRC individuals. For the FY 2006 workplan, the outside costs are shown only in the individual project budget tables, as well as in APPENDICES A and C.

<sup>2</sup>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.

<sup>3</sup>In FY2006 the Logistics Program Manager's salary is included in the Administrative Program Planning & Development portion of the GCMRC budget (see lines #146 in APPENDICES A and C (see F.2).

<sup>4</sup>These administrative costs are now included in the GCD-AMP budget (see lines #19 of APPENDICES A & C)

**Principal Investigators:** C. Fritzinger and P. 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 GCD-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 Coordination
- Library Operations Coordination
- Survey Support Coordination
- Technical Support Coordination
- Logistics Operations Coordination

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 25-40 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.

**Implications of Experimental vs. Non-Experimental Scenarios:** Under the "With Experiment" scenario, the funding available to replace equipment in the warehouse is reduced by more than half (\$100,000 down to \$42,000) and this will delay upgrades of worn equipment at the same time that additional use occurs to support ongoing Mechanical Removal activities. Additional funds will be to be made available in FY 2007 and beyond to replace and upgrade

river logistics equipment. Under the “Non-Experimental” scenario, funds for this area of the program are the same as originally proposed in the February 2005 version of the workplan.

### **Project D.2. Ongoing Survey Operations**

<b>FUNDING HISTORY</b>	<b>Fiscal year</b>				
	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>
<b>Outside GCMRC Science/Labor</b>	<b>0</b>	<b>0</b>	<b>33,000</b>	<b>0</b>	<b>18,150</b>
<b>Logistics Field Support</b>	<b>0</b>	<b>0</b>	<b>12,200</b>	<b>45,200</b>	<b>20,000</b>
<b>Operations/Supplies (includes equipment)</b>	<b>35,000</b>	<b>36,000</b>	<b>36,800</b>	<b>68,800</b>	<b>0</b>
<b>GCMRC Salaries</b>	<b>35,550</b>	<b>41,180</b>	<b>44,000</b>	<b>44,000</b>	<b>64,900</b>
<b>Project Subtotal</b>	<b>—</b>	<b>—</b>	<b>—</b>	<b>—</b>	<b>103,050</b>
<b>DOI 17% Customer Burden</b>	<b>70,550</b>	<b>77,180</b>	<b>126,000</b>	<b>158,000</b>	<b>17,919</b>
<b>Project Total</b>	<b>0</b>	<b>0</b>	<b>26%</b>	<b>0</b>	<b>120,969</b>
<b>% Total Outsourced</b>	<b>—</b>	<b>—</b>	<b>31%</b>	<b>14%</b>	<b>23%</b>

**Principal Investigators:** K. Brown, U.S. Geological Survey

**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, kinematics and Real Time Kinematics (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 FY06 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

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

**Implications of Experimental vs. Non-Experimental Scenarios:** Under the “With Experiment” scenario, the funding available to support survey activities is reduced and this reduction will delay progress to some degree on the development of the geodetic control network (see next section). Under the “Non-Experimental” scenario, funds for this area of the program are the same as originally proposed in the February 2005 version of the workplan.

### **Project D.3. Ongoing Development of Geodetic Control Network**

<b>FUNDING HISTORY</b>	<b>Fiscal year</b>				
	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>
<b>Outside GCMRC Science/Labor</b>	—	—	<b>0</b>	<b>50,000</b>	<b>30,000</b>
<b>Logistics Field Support</b>	—	—	<b>54,000</b>	<b>52,000</b>	<b>25,000</b>
<b>Operations/Supplies</b>	—	—	<b>10,000</b>	<b>20,000</b>	<b>0</b>
<b>GCMRC Salaries</b>	—	—	<b>22,000</b>	<b>33,000</b>	<b>66,000</b>
<b>Project Subtotal</b>	—	—	<b>86,000</b>	<b>155,000</b>	<b>121,000</b>
<b>2006 DOI Customer Burden (17%)</b>	—	—	<b>12,900</b>	<b>23,250</b>	<b>22,015</b>
<b>Project Total</b>	—	—	<b>98,900</b>	<b>178,500</b>	<b>143,015</b>
<b>% Total Outsourced</b>	—	—	<b>27%</b>	<b>43%</b>	<b>30%</b>

**Principal Investigators:** K. Kohl, U.S. Geological Survey

**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 FY06 Funding Recommendations:** Funding decrease in this year will delay ongoing efforts to complete the control network.

**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

**Implications of Experimental vs. Non-Experimental Scenarios:** Under the “With Experiment” scenario, the funding available to support control network activities is reduced and this reduction will delay progress to some degree on the development of the geodetic control network (see next section). Owing to the fact that there are no additional remote-sensing overflights planned during FY 2006, as this time, this delay in the progress of the work is not a major problem. However, additional funding will be needed in FY 2007 to keep this effort moving ahead. Under the “Non-Experimental” scenario, funds for this area of the program are the same as originally proposed in the February 2005 version of the workplan.

## E. INFORMATION TECHNOLOGY SUPPORT (PROVIDED BY SBSC)

### Project E.1. Ongoing Information Technology Activities

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor	—	—	—	65,000	133,000 <sup>1</sup>
Travel & Training	—	—	—	0	5,000
Operations/Supplies	—	—	—	10,000	165,000
GCMRC Salaries	—	—	—	0	See footnote <sup>2</sup>
<b>Project Subtotal</b>	—	—	—	<b>75,000</b>	<b>303,000</b>
<b>2006 DOI Customer Burden (17%)</b>	—	—	—	<b>11,250</b>	<b>51,510</b>
<b>Project Total</b>	—	—	—	<b>86,250</b>	<b>354,510</b>
<b>% Total Outsourced</b>	—	—	—	<b>75%</b>	<b>38%</b>

<sup>1</sup>These costs cover seventy-five percent of an SBSC IT-Specialist (GS-12) and 100% of an SBSC IT-Specialist (GS-9) salary as contribution to GCMRC's need for Information Technology support.

<sup>2</sup>Seventy-five percent of the SBSC Information Technology Director's salary is covered under item F.2 (Program Planning & Development) as shown in lines #146 of APPENDICES A and C.

**Principal Staff:** M. Liszewski, IT Director for SBSC, D. Blank, SBSC, U.S. Geological Survey

**Summary Project Description:** The Information Technologies Department of the SBSC supports a variety of technology needs of the GCMRC's various program areas: computer security, systems administration and procurement of new servers and computers, as well as web site development and web page maintenance. These support, development and maintenance services are cost shared between the GCMRC and the SBSC and the IT Department is coordinated by the Center's Deputy Director so as to meet the IT needs of all four of the research stations.

**MO's and IN's ADDRESSED:** The Information Technology Department of the SBSC supports the GCMRC's computer needs intended to provide a centrally located distribution point for data and information relating to all GCMRC science activities. These activities generally relate to the 12 Goals of the GCD-AMP's Strategic Plan, but most centrally to Goal #12, ensuring a quality science-based Adaptive Management Program.

**Consequences of FY06 Funding Recommendations:** The currently proposed budget for FY 2006 provides for the continued development and IT support at a level that will allow the computing and related technology needs to be continued and the web site development ongoing.

**Status/Schedule:** The GCMRC Information Technology Department was formally established in 1998, but with the creation of the Southwest Biological Science Center in 2002, the need for Information Technology support expanded from one to four research stations. In FY 2006, the IT Department becomes a more centralized element of the SBSC, so as to continue meeting the needs of the GCMRC, as well as the needs of the other three research stations. The IT Department's development is expected to continue through 2006 and beyond as the four research stations evolve. It is anticipated that new development cycles will need to commence on 1 to 3 year intervals depending upon the changing needs of the SBSC science activities, user needs, and advances in technology.

**Expected Products and Services:** The primary products and services of the SBSC Information Technology Department with respect to ongoing support of the GCMRC's needs are:

- Comprehensive and fully functional website development and maintenance, 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.
- Coordination with GCMRC's DASA to ensure and support a 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.
- 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

- 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 States.
  - 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.
  - Assistance and support of 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.
  - Assistance with GCMRC’s 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.

## **CHAPTER 4**

### **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 four Program Managers: Physical Science, Modeling and DASA Program, Biological Sciences, Socio-cultural, and Logistics Support Program. As mentioned above, a Biology Program Manager position is being filled in summer 2005; at this time the position is filled with an Acting Biology Program Manager. The Program Managers provide GCMRC support to the Chief and oversee the individual resource areas and an extensive program of data analysis and management. The DASA's GIS, DBMS, Remote-Sensing, Library are coordinated jointly with the SBSC's IT Department, as well as the Logistics and Survey staff, to collaborate in support of program integration and evaluation of the influence of Glen Canyon 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 Colorado River Ecosystem (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 leads with their cooperators.

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 25 and 40 river trips in FY 2006. As mentioned in Chapter 1, the administrative costs for supporting NPS permitting have been included in the Administrative budget of this version of the FY 2006, draft workplan and budget. This change was recommended by the Technical Workgroup's Budget ad hoc group in spring 2005 and the GCMRC concurs with this recommendation (see line #19 of Appendices A and C, attached).

## F. ADMINISTRATION AND MANAGEMENT

### F.1. Administrative Operations

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
<b>Outside GCMRC Admin costs</b>	—	—	395,000	400,000	15,000
<b>Logistics Field Support</b>	—	—	—	—	0
<b>Project Related Travel/Training</b>	—	—	—	—	40,795
<b>Operations/Supplies</b>	—	340,500	154,000	160,000	314,500
<b>GCMRC Salaries</b>	—	243,500	71,000	78,000	290,000
<b>Subtotal</b>	—	—	—	—	660,295
<b>DOI Customer Burden (17%)</b>	—	—	—	—	112,250
<b>Project Total</b>	—	584,000	620,000	638,000	772,545
<b>% Total Outsourced</b>	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 (including approximately \$150,000 re-location support fund for hire of a new Chief), space and facilities, non-project related travel and training, vehicles, office supplies and equipment and maintenance. Also included are costs for the USGS local network, Flagstaff Science Center support, and USGS regional services including contracting and personnel. During FY 2006, the SBSC plans to support the salaries associated with the Budget Analyst and Chief's Secretary. Hence, these costs are not included in this budget line item.

## F.2. Program Planning and Management

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
<b>Outside GCMRC Science/Labor</b>	—	—	—	—	<b>0</b>
<b>Logistics Field Support</b>	—	—	—	—	<b>0</b>
<b>Project Related Travel/Training</b>	—	—	—	—	<b>15,000</b>
<b>Operations/Supplies</b>	—	<b>226,000</b>	<b>20,000</b>	<b>22,000</b>	<b>4,800</b>
<b>GCMRC Salaries</b>	—	<b>243,000</b>	<b>254,000</b>	<b>260,000</b>	<b>458,200</b>
<b>Subtotal</b>	—	—	—	—	<b>478,000</b>
<b>DOI Customer Burden (17%)</b>	—	—	—	—	<b>81,260</b>
<b>Project Total</b>		<b>584,000</b>	<b>274,000</b>	<b>282,000</b>	<b>559,260</b>
<b>% Total Outsourced</b>	<b>0%</b>	<b>0%</b>	<b>0%</b>	<b>0%</b>	<b>0%</b>

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. In addition to the four program managers, seventy-five percent of the salary for the SBSC's Information Technologies Director is also included in this line item to support the GCMRC's ongoing IT needs. Travel expenses in support of the program, but separate from TWG and AMWG participation are also included. These costs are for the four Program Managers: Physical Science, Modeling and DASA; Biological Sciences; Socio-cultural Resources; and the Logistics Support Program.

### F.3. AMWG/TWG Participation (GCMRC travel & per diem only)

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 (17%)	—	—	—	—	2,550
<b>Project Total</b>	—	<b>38,500</b>	<b>45,000</b>	<b>46,350</b>	<b>17,550</b>
<b>% Total Outsourced</b>	<b>0%</b>	<b>0%</b>	<b>0%</b>	<b>0%</b>	<b>0%</b>

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	325,000
Logistics Field Support	—	—	—	—	0
Project Related Travel/Training	—	—	—	—	0
Operations/Supplies	—	—	—	—	0
GCMRC Salaries	—	10,000	22,000	32,000	0
Subtotal	—	—	—	—	325,000
DOI Customer Burden (17%)	—	—	—	—	55,250
<b>Project Total</b>	—	<b>99,000</b>	<b>222,000</b>	<b>272,000</b>	<b>380,250</b>
<b>% Total Outsourced</b>	<b>0%</b>	<b>90%</b>	<b>90%</b>	<b>90%</b>	<b>100%</b>

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 three to six person-months, but requires no additional salary and is the responsibility of the Librarian/Review Coordinator. The Review Coordinator reports to the Chief directly, but works under the guidance of the DASA Coordinator for all non-review related activities.

### 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 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 sector. 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 (SSIP), (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.

Involvement by the Science Advisors and their Executive Director in the Strategic Science Planning process in FY 2006, requires some additional level of activity and interactions with the GCMRC and the various members of the several planning ad hoc committees. Additional funding is required to support this elevated level of involvement by the Science Advisors and other experts. The request by the AMWG for the Executive Director of the Science Advisors to attend and participate more actively in all of the GCD-AMP meetings again requires a higher level of funding support for the category of Independent Review in FY 2006 and beyond. In order to limit the need to increase funding beyond what is proposed in the FY 2006 draft budgets, GCMRC recommends that the number of active Science Advisors be strategically focused in the future, and limited to eight rather than ten or more members. To facilitate discussion in this area of the program, the GCMRC suggests that the following program areas be represented by future Science Advisors:

- Adaptive Management Practice
- Fisheries
- 2<sup>nd</sup> Fishery Role with added focus in Aquatic Ecology
- Cultural Resources
- Recreation/Economics
- Quality-of-Water
- Sediment and Geomorphic Process
- Systems Ecology and Modeling

#### F.5. Support for Strategic Science Implementation Planning

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor	—	—	—	—	25,000
Logistics Field Support	—	—	—	—	0
Project Related Travel/Training	—	—	—	—	0
Operations/Supplies	—	—	—	—	0
GCMRC Salaries	—	—	—	—	0
Subtotal	—	—	—	—	25,000
DOI Customer Burden (17%)	—	—	—	—	4,250
Project Total	—	—	—	—	29,250
% Total Outsourced	—	—	—	—	100%

**Strategic Science Planning** – The additional required activities associated with multi-faceted planning tasks in FY 2005-06 has been identified as a requirement to complete the Strategic Science Implementation Plan, as well as the various Core-Monitoring, Research, Experimental and Humpback Chub Comprehensive Plan sub-elements of the SSIP. Additional funds are intended to support external facilitation and participation by experts in the various resources areas, as well as in the realm of adaptive management implementation, etc. The funds shall be used to support travel and per diem of those invited to attend planning sessions, as well as to support an existing cooperative agreement to provide ongoing facilitation of planning meetings aimed at completing the experimental design element of the SSIP.

**F.6. GCMRC's FY 2006 Biennial Science Symposium**

<b>FUNDING HISTORY</b>	<b>Fiscal year</b>				
	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>
<b>Outside GCMRC Science/Labor</b>	—	—	—	—	<b>25,000</b>
<b>Logistics Field Support</b>	—	—	—	—	<b>0</b>
<b>Project Related Travel/Training</b>	—	—	—	—	<b>0</b>
<b>Operations/Supplies</b>	—	—	—	—	<b>0</b>
<b>GCMRC Salaries</b>	—	—	—	—	<b>0</b>
<b>Subtotal</b>	—	—	—	—	<b>25,000</b>
<b>DOI Customer Burden (17%)</b>	—	—	—	—	<b>4,250</b>
<b>Project Total</b>	—	—	—	—	<b>29,250</b>
<b>% Total Outsourced</b>	—	—	—	—	<b>100%</b>

**Convening of Science Symposia to Facilitate Information Transfer** – The GCMRC has convened and hosted Biennial Science Symposia in the springs of 1997, 1999, 2001 and fall of 2003. These meetings are intended to facilitate critical information transfer and promote science and management discussions as new information is derived from the science and GCD-AMP efforts. The costs associated with these meetings have never been explicitly shown in annual workplans and budget. To better document the implementation of these meetings in the future, the GCMRC includes an estimate of the cost for the next, upcoming meeting in this workplan. The schedule for the FY 2006 Biennial Science Symposium, is set for October 25-27, 2005, and will be held in Tempe, AZ. The GCMRC seeks additional input from the GCD-AMP on how the Biennial Science Symposium can be improved to better meet the information transfer needs of the managers.

### F.7. Experimental Support Fund for FY 2007 and Beyond

FUNDING HISTORY	Fiscal year				
	2002	2003	2004	2005	2006
Outside GCMRC Science/Labor	—	—	—	—	600,000
Logistics Field Support	—	—	—	—	0
Project Related Travel/Training	—	—	—	—	0
Operations/Supplies	—	—	—	—	0
GCMRC Salaries	—	—	—	—	0
Subtotal	—	—	—	—	600,000
DOI Customer Burden (0%)	—	—	—	—	0 <sup>1</sup>
Project Total	—	—	—	—	600,000
% Total Outsourced	—	—	—	—	100%

<sup>1</sup>The DOI burden would not be charged until the funds are obligated or expended in FY 2007 or beyond.

**Experimental Funding (Proposed Carry-Forward to FY 2007 and Beyond)** – On the basis of the recommendation of the Technical Workgroup’s Budget ad hoc group, this fund is intended to provide a carry-forward toward reestablishment of the Experiment Support fund. This strategy is similar to the approach taken by the program in 2000-2003, when carry-forward funds were accumulated to support eventual implementation of the experimental science activities in FY 2003-2005. This budget amount reflects the attempt by the Budget ad hoc committee and the GCMRC staff to approach a targeted amount of \$750,000, as well as implement two experimental treatments recommended by the GCMRC for FY 2006 (see Chapter 1), and fund conservation measure activities identified by the Humpback Chub Comprehensive Plan ad hoc group. In the “Non-Experiment” version of the FY 2006 budget and workplan, an experimental fund of just over \$1,000,000 was identified as a carry-forward possibility, even with ongoing support for humpback chub conservation measures, ongoing provisional monitoring and completion of reporting on the 2004 sediment experimental work, as well as support for additional science planning.

**F.8. AMWG, TWG Requests During FY 2006**

<b>FUNDING HISTORY</b>	<b>Fiscal year</b>				
	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>
<b>Outside GCMRC Science/Labor</b>	—	—	—	—	<b>75,000</b>
<b>Logistics Field Support</b>	—	—	—	—	<b>0</b>
<b>Project Related Travel/Training</b>	—	—	—	—	<b>0</b>
<b>Operations/Supplies</b>	—	—	—	—	<b>0</b>
<b>GCMRC Salaries</b>	—	—	—	—	<b>0</b>
<b>Subtotal</b>	—	—	—	—	<b>75,000</b>
<b>DOI Customer Burden (17%)</b>	—	—	—	—	<b>12,750</b>
<b>Project Total</b>	—	—	—	—	<b>87,750</b>
<b>% Total Outsourced</b>	—	—	—	—	<b>100%</b>

**Contingency for Unexpected Requests from the GCD-AMP** – This funding is recommended by the GCMRC as a placeholder in the event that additional needs are identified by the GCD-AMP during the course of FY 2006.

**TASK AND AD HOC GROUPS**

Task and ad hoc groups have been established over time by the GCD-AMP in areas where GCMRC seeks on-going dialogue and guidance for specific science issues. In one sense, this also applies to interactions between the Science Advisors and the GCMRC staff (tasks related to science advisory and external expert review). Several task and ad hoc groups are described below; the experience of the GCMRC has been such that it believes that other task groups will likely continue to be formed as needs arise. The proposal for supporting the task groups involved in the multi-faceted science planning process is to utilize additional funds in the FY 2006 budget related to: 1) strategic science planning (see F.7), 2) Dam Operations Experiment (see B.9) and 3) increased funding in the area of Independent Review (see F.4).

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. This 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.

Several ad hoc groups are currently working in the following key planning areas in an attempt to build a solid Strategic Science Implementation Plan that is supported by the GCD-AMP and effectively accomplished by the GCMRC:

- Experimental Ad hoc
- Core-Monitoring Ad hoc
- Strategic Science Plan Ad hoc
- Humpback Chub Comprehensive Ad hoc

### **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. In FY 2006, the customer rate will rise to 17% to achieve the required additional facilities costs. 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 level 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 FY 2004, USGS Headquarters approved the special rate of 6% for only a portion of GCMRC's power revenue funding. This rate was applied to approximately \$2 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 requested for GCMRC (also \$1 million) is not likely to be added to the funding table (refer to line #198). However, information has been forwarded to the GCMRC that the required DOI cost share funds will be provided by the USGS Headquarters, so as to continue allowing for the reduced customer rate to apply to the GCMRC science program in FY 2006. 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. The issue relating to how these cost share funds are derived in the future is a major area of concern for the GCMRC science program. Discussion among members of the GCD-AMP on this topic is highly encouraged by the GCMRC as the initial attempts are undertaken to draft an FY 2007-08, combined workplan and budget.

In the FY2006 budget proposal and spreadsheet (see Appendices A and C, 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 \$10,828,000 and \$10,692,000 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 \$219,000, respectively, from the Bureau of Reclamation Water Quality fund for both years.

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**APPENDIX A**  
**(See Supplemental Excel Spreadsheet)**

**FY 2006 BUDGET WITH GCMRC'S EXPERIMENTAL RECOMMENDATIONS**

**FY2006 Budget Footnotes: WITH GCMRC's RECOMMENDED EXPERIMENTAL TREATMENTS & RECOMMENDED HUMPBACK CHUB ACTIONS**

- (1) The Logistics NPS Permitting costs are included above the line under BOR AMWG Administrative support (item #5)
- (2) CPI adjustment of 2.5% used for FY2006
- (3) Cost share is the difference between the USGS full burden rate (37 to 42%) and the DOI customer rate (17%). USGS full burden rate varies between fiscal years; the DOI customer rate has remained steady since FY2003 (when enacted) at 15%. An additional 2% is added in FY 2006 to cover facilities charges.
- (4) The FY 2006 budgets for these "other related projects" will need to be provided by agencies involved in the undertakings

**FY2006 Budget Assumptions:**

\*The budget reflects the confirmed information that the USGS would again approve a special "pass-through" rate of 6% for GCMRC; it has been factored into the budget as accurately as is feasible at this time.

\*Budget based on the assumption that BOR contributes \$200K for TCD, special rate of 6% is applied here

\*GCMRC budget based on assumption that the DOI Customer Burden Rate will be 17% and that the USGS Bureau contributes approximately \$1 million for the cost share portion of the burden.

**This version of the budget is developed around the option for WITH RECOMMENDED EXPERIMENTAL TREATMENTS IMPLEMENTED IN FY 2006**

Indirect costs do not apply to the carry-forward amount until they are expended or obligated in the out year.

Cells in column A that contain project numbers, such as "A.2", **AND** are highlighted in **LIGHT GREEN**, indicate that they are proposed and recommended by the GMCRC for funding and implementation in the FY 2006 workplan

AMP DRAFT	BUDGET FY2006	C	D	E	F	G	H	I	J	K	L	M	N	Revised Date: 07/26/2005
FY	ID	Project Descriptions	BOR Approved FY04 Budget	BOR Approved FY05 Budget	BOR Draft FY06 Budget	Comments								
2														
3		<b>Reclamation Administration Power Revenue Funded Projects</b>												
4	A.	<b>Adaptive Management Work Group</b>												
5	1	Personnel Costs	151,000	155,530	159,418									
6	2	AMWG Member Travel Reimbursement	13,000	13,390	15,725									
7	3	Reclamation Travel	18,000	15,540	13,000									
8	4	Facilitation Contract	21,000	21,000	25,000									
9	5	Other	9,000	7,000	7,175									
10		<b>BOR AMWG Subtotal</b>	<b>212,000</b>	<b>212,460</b>	<b>220,318</b>									
11	B.	<b>Technical Work Group</b>												
12	1	Personnel Costs	69,000	71,070	72,847									
13	2	TWG Member Travel Reimbursement	15,000	15,450	20,836									
14	3	Reclamation Travel	17,000	15,510	15,898									
15	4	TWG Chair Reimbursement	21,000	21,630	22,171									
16	5	Other	2,000	2,000	2,050									
17		<b>TWG Subtotal</b>	<b>124,000</b>	<b>125,660</b>	<b>133,801</b>									
18	C.	<b>Other</b>												
19	1	Compliance Documents	26,000	26,780	22,450									
20	2	Administrative Support for NPS Permitting <sup>(1)</sup>			100,000									This administrative cost formerly appeared in the science budget. BAHG resolved on 5/31/05 that this admin cost be moved to above the science line.
21	3	Contract Administration	25,000	25,750	24,394									
22		<b>OTHER Subtotal</b>	<b>51,000</b>	<b>52,530</b>	<b>146,844</b>									
23	D.	<b>Public Outreach</b>	85,000	50,000	-									Moved from USGS in FY05 & 06; Ad Hoc formed 1/7/04 to develop program in FY04; HBC included..
24	E.	<b>Development of an LCR Management Plan</b>	0	100,000	-									BOR: Plan to cover Biological Opinion responsibilities
25		<b>Reclamation Administrative Subtotal</b>	<b>472,000</b>	<b>540,650</b>	<b>500,964</b>									
26														
27	F.	<b>Programmatic Agreement Cultural Resources</b>												
28	1	Reclamation Administration	43,000	51,500	52,788									
29	2	NPS-GRCA Monitoring Costs	200,000	206,000	-									FY06 Moved under GCMRC Cultural Monitoring budget
30	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.
31	4	NN & GLCA Treatment Plan and Implementation	100,000	100,000	20,000									Should be completed with 20K in FY06
32	5	Canyon Treatment Plan and Implementation	0	250,000	250,000									
33	6	Zuni Conservation Program Mitigation	0	10,000	-									Covered under treatment
34	7	TCP GIS Documentation	0	30,000	-									
35		<b>PA Subtotal</b>	<b>371,000</b>	<b>676,340</b>	<b>322,788</b>									
36		<b>Reclamation Power Revenue Program Subtotal</b>	<b>843,000</b>	<b>1,216,990</b>	<b>823,752</b>									
37														
38		<b>Reclamation Administration NON-Power Revenue Funded Projects</b>												
39	G.	<b>Tribal Consultation</b>												
40		<b>Cooperative Agreements with Tribes</b>												
41	1	Hopi Tribe	80,000	80,000	97,850									TWG requests more info on products. Also, no dedicated funding for river trips, but they may be supported from these funds if need is specified
42	2	Hualapai Tribe	80,000	80,000	97,850									TWG requests more info on products. Also, no dedicated funding for river trips, but they may be supported from these funds if need is specified
43	3	Navajo Nation	80,000	80,000	97,850									TWG requests more info on products. Also, no dedicated funding for river trips, but they may be supported from these funds if need is specified
44	4	Pueblo of Zuni	80,000	80,000	97,850									TWG requests more info on products. Also, no dedicated funding for river trips, but they may be supported from these funds if need is specified
45	5	Southern Paiute	80,000	80,000	97,850									TWG requests more info on products. Also, no dedicated funding for river trips, but they may be supported from these funds if need is specified
46		<b>Tribal Consultation Subtotal</b>	<b>400,000</b>	<b>400,000</b>	<b>489,250</b>									
47		<b>River Trips for Consultation and DOEs</b>												
48	1	Hopi Tribe	0	15,000	-									See comments above
49	2	Hualapai Tribe	0	15,000	-									See comments above
50	3	Navajo Nation	0	15,000	-									See comments above
51	4	Pueblo of Zuni	0	15,000	-									See comments above
52	5	Southern Paiute	0	15,000	-									See comments above
53		<b>Tribal River Trip Subtotal</b>	<b>0</b>	<b>75,000</b>	<b>0</b>									
54		<b>Tribal Subtotal</b>	<b>400,000</b>	<b>475,000</b>	<b>489,250</b>									
55		<b>Reclamation NON-Power Revenue Subtotal</b>	<b>400,000</b>	<b>475,000</b>	<b>489,250</b>									
56														
57		<b>BUREAU OF RECLAMATION TOTAL AMP PROGRAM COSTS:</b>	<b>1,243,000</b>	<b>1,691,990</b>	<b>1,313,002</b>									
58														



AMP DRAFT		BUDGET FY2006											Revised Date: 07/26/2005	
FY	GCMRC Work Plan ID	ID	Project Descriptions	Approved FY04 Budget	Approved FY05 Budget	Outside GCMRC Science/Labor	Logistics Field Support	Project Related Trvl/Training	Operations / Supplies	GCMRC Salaries	Project Subtotal (w/o Burden)	DOI Customer Burden (6 or 17%)	DRAFT FY06 Budget - Gross (inc. Burden)	Comments
128		D	Logistics Support											
129	D.1	L&S	Logistics (Dispersed throughout projects)			-	-	-	42,000	62,800	104,800	17,816	122,616	Additional funds needed to refurbish and replace river equipment prior to Phase II experimentation
130	D.2	L&S	Survey Operations	126,000	126,000	18,150	20,000	-	-	64,900	103,050	15,522	118,572	Ongoing field and office support for science projects and control network development (see D.3)
131		EXP	Technical Support - Survey Equipment	32,000	32,000	-	-	-	-	-	-	-	-	No additional work is scheduled in support of High-flow Test research in WY 2006
132	D.3	L&S	Control Network	86,000	150,000	30,000	25,000	-	-	66,000	121,000	17,270	138,270	Ongoing support for development of the Canyon-wide control network
133			<b>Logistics Support Subtotal</b>	<b>244,000</b>	<b>308,000</b>	<b>48,150</b>	<b>45,000</b>	<b>0</b>	<b>42,000</b>	<b>193,700</b>	<b>328,850</b>	<b>50,608</b>	<b>379,458</b>	
134		E	Information and Outreach Program											
135	E-4	IPO	Web page and product development	-	75,000	-	-	-	-	-	-	-	-	Web design included in Sys Admin for FY06;GS 5/7 Web Page Employee
136	E.1	IPO	GCMRC Component of SBSC Sys Admin Support	242,000	242,000	-	-	5,000	165,000	133,000	303,000	51,510	354,510	75% of GS-12 and 100% of GS-9 IT positions in support of system administration at the GCMRC FY06. GS-7 IT position covered by SBSC
137	E-2	EXP	Systems Administration & Computer Technical Support	21,000	21,000	-	-	-	-	-	-	-	-	No additional work is scheduled in support of High-flow Test research in WY 2006
138			<b>Information Office Subtotal</b>	<b>263,000</b>	<b>338,000</b>	<b>0</b>	<b>0</b>	<b>5,000</b>	<b>165,000</b>	<b>133,000</b>	<b>303,000</b>	<b>51,510</b>	<b>354,510</b>	
139		F	Admin. & Tech. Supp. Services											
140		F	Administrative & Management											
141	F.1	ADM	Administrative Operations <sup>(1)</sup>	620,000	638,600	15,000	-	40,795	314,500	290,000	660,295	112,250	772,545	Includes full-time GS-15 salary for the GCMRC Chief's position, plus moving costs for new Chief to Flagstaff
142	F-4	EXP	Administrative Support	5,000	5,000	-	-	-	-	-	-	-	-	No additional work is scheduled in support of High-flow Test research in WY 2006
143	F.2	ADM	Program Planning & Management	274,000	282,220	-	-	15,000	10,940	458,200	484,140	82,304	566,444	Full-time salaries for Physical, Biological, Cultural, Logistics program managers and 75% for Information Officer
144	F.3	ADM	TWG/AMWG Participation	45,000	46,350	-	-	15,000	-	-	15,000	2,550	17,550	Travel support only
145	F.4	ADM	Independent Reviews	222,000	272,000	325,000	-	-	-	-	325,000	55,250	380,250	Additional support required to support additional strategic planning efforts in FY06.
146	F.5	TBD	GCMRC's additional Strategic Planning Support			25,000	-	-	-	-	25,000	4,250	29,250	Additional support required to support additional strategic planning efforts in FY06.
147	F.6	TBD	GCMRC Science Symposium			25,000	-	-	-	-	25,000	4,250	29,250	Required support for the October 2005 Biennial Science Symposium in Tempe, AZ
148	F.7	EXP	Projected FY06 Carry Forward for Experiment Phase II			600,000	-	-	-	-	600,000	-	600,000	Projected FY06 carry forward to support EXP Phase II treatments in FY 2007-08 (cost share and burden not required until FY 2007)
149		ADM	Public Outreach (Moved to BOR)	0	0	-	-	-	-	-	-	-	-	A: Moved to BOR in FY2006; Hoc formed 1/7/04 to develop program in FY04; HBC included
150	F.8	AMP	AMWG, TWG Requests	0	73,000	75,000	-	-	-	-	75,000	12,750	87,750	Continuation of funding to supports needs that are identified throughout the year, following budget and workplan approval
151		AMP	Unsolicited Proposals (Other research activities)	0	50,000	-	-	-	-	-	-	-	-	No additional funds designated for unsolicited proposals in FY06
152			<b>Administrative &amp; Management Subtotal</b>	<b>1,166,000</b>	<b>1,367,170</b>	<b>1,065,000</b>	<b>-</b>	<b>70,795</b>	<b>325,440</b>	<b>748,200</b>	<b>2,209,435</b>	<b>273,604</b>	<b>2,483,039</b>	
153			<b>Logistics, Info Office &amp; Admin Support Subtotal</b>	<b>1,673,000</b>	<b>2,013,170</b>	<b>1,113,150</b>	<b>45,000</b>	<b>75,795</b>	<b>532,440</b>	<b>1,074,900</b>	<b>2,841,285</b>	<b>375,722</b>	<b>3,217,007</b>	
154			<b>GCMRC Power Revenue Subtotal</b>	<b>8,630,000</b>	<b>7,658,670</b>	<b>3,278,520</b>	<b>841,000</b>	<b>117,795</b>	<b>649,690</b>	<b>2,183,255</b>	<b>7,070,260</b>	<b>892,282</b>	<b>7,962,542</b>	
155			<b>U.S. Geological Survey - Biological Resource Division - GCMRC - NON-Power Revenue Funded Projects</b>											
156	A	A	Lake Powell											
157	A.1	CM	Lake Powell Monitoring	210,000	210,000	-	-	10,000	38,924	138,250	187,174	31,820	218,994	Assumes BOR pays NPS directly for position (25-35K)
158	B.11	HCA	Temperature Control Device (TCD)	200,000	50,000	188,680	-	-	-	-	188,680	11,321	200,001	GCMRC prepared a workplan and budget in collaboration with BuRec during spring 2005, report on this work will be made at June 2005 TWG.
159		RES	Kanab Ambersnail Taxonomy (USGS Appr. Only)	88,000	0	-	-	-	-	-	-	-	-	Implemented with USGS appropriations in FY04 only
160			<b>GCMRC NON-Power Revenue Funded Project Subtotal</b>	<b>498,000</b>	<b>260,000</b>	<b>188,680</b>	<b>0</b>	<b>10,000</b>	<b>38,924</b>	<b>138,250</b>	<b>375,854</b>	<b>43,140</b>	<b>418,994</b>	
161			<b>GCMRC TOTAL AMP PROGRAM COSTS:</b>	<b>9,128,000</b>	<b>7,918,670</b>	<b>3,467,200</b>	<b>841,000</b>	<b>127,795</b>	<b>688,614</b>	<b>2,321,505</b>	<b>7,446,114</b>	<b>935,422</b>	<b>8,381,536</b>	
162			<b>BOR &amp; USGS-GCMRC AMP PROGRAM COSTS</b>	<b>FISCAL YEAR 2004</b>	<b>FISCAL YEAR 2005</b>	<b>FISCAL YEAR 2006</b>								
163			BOR Power Revenue Program Costs	843,000	1,216,990	823,752								
164			GCMRC Power Revenue Program Costs (net)	7,578,261	6,703,191	7,070,260								
165			GCMRC DOI Customer Burden (Indirect Costs)	1,136,739	1,005,479	892,282								
166			<b>Subtotal BOR &amp; GCMRC Power Revenue Program Costs</b>	<b>9,558,000</b>	<b>8,925,660</b>	<b>8,786,293</b>								
167			BOR Non-Power Revenue Program Costs	400,000	475,000	489,250								
168			GCMRC Non-Power Revenue Program Costs	498,000	260,000	375,854								
169			GCMRC DOI Customer Burden (Indirect Costs)	0	0	43,140								
170			<b>Subtotal BOR &amp; GCMRC Non-Power Revenue Program Costs</b>	<b>898,000</b>	<b>735,000</b>	<b>908,244</b>								
171			Estimated Cost Share expense required by USGS policy <sup>(3)</sup>	1,000,000	1,000,000	1,000,000								
172			<b>TOTAL AMP PROGRAM COSTS (BOR &amp; GCMRC):</b>	<b>11,456,000</b>	<b>10,660,660</b>	<b>10,694,537</b>								
173			<b>FUNDING:</b>	<b>FY 2004</b>	<b>FY 2005</b>	<b>FY06(2)</b>								
174			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
175			FY04 Carry Over	0	0	0								Updated to reflect the actuals determined for FY 2004
176			FY05 Previously Unidentified Funds (EHF)	0	848,000	0								
177			USGS Appropriations <sup>(3)</sup>	1,100,000	1,000,000	1,097,375								At this time, USGS appropriations are identified from HQ sources for use by GCMRC in FY06 to cover the Cost Share; \$97,375 is the USGS tribal support funding.
178			USBR Appropriations <sup>(4)</sup>	295,000	295,000	297,375								BOR appropriations unknown at this time -included \$200K for TCD and \$97,375 for tribal support
179			NPS Funds <sup>(5)</sup>	167,000	167,000	0								
180			NPS Appropriations <sup>(3)</sup>	95,000	95,000	97,850								Tribal support
181			FWS Appropriations <sup>(3)</sup>	95,000	95,000	97,850								Tribal support
182			BIA Appropriations <sup>(3)</sup>	95,000	95,000	97,850								Tribal support

AMP DRAFT		BUDGET FY2006			Revised Date: 07/26/2005									
FY	GCMRC Work Plan ID	ID	Project Descriptions	Approved FY04 Budget	Approved FY05 Budget	Outside GCMRC Science/Labor	Logistics Field Support	Project Related Trvl/Training	Operations / Supplies	GCMRC Salaries	Project Subtotal (w/o Burden)	DOI Customer Burden (6 or 17%)	DRAFT FY06 Budget - Gross (inc. Burden)	Comments
59			BOR Operations & Maintenance (IQWP)	210,000	210,000	218,994								
190			USGS Funds for Remote Sensing	180,000	0	0								
191			<b>TOTAL AVAILABLE FUNDS</b>	<b>10,600,000</b>	<b>11,377,000</b>	<b>10,693,594</b>								
192			<b>TOTAL FUNDING NEEDED</b>	<b>11,663,000</b>	<b>10,827,660</b>	<b>10,694,537</b>								
193			<b>SUB-TOTAL AVAILABLE FUNDS - ESTIMATED COSTS</b>	<b>(1,063,000)</b>	<b>549,340</b>	<b>(944)</b>								
194			Experimental High Flows Testing - 11/2004	0	549,340	8								FY05-This is not a surplus! These funds have been expended for the EHF test. They were not applied to the project portion of the spreadsheet because of time factors.
195			<b>TOTAL AVAILABLE FUNDS - ESTIMATED COSTS</b>	<b>(1,063,000)</b>	<b>0</b>	<b>(952)</b>								
196														
197														
198			<b>OTHER RELATED PROJECTS*</b>	<b>FISCAL YEAR 2004</b>	<b>FISCAL YEAR 2005</b>	<b>FISCAL YEAR 2006</b>								
199			<b>US Fish &amp; Wildlife Service</b>											
200	HCA		HBC Captive Breeding/Refugia	40,000	0	?								USFWS responsibility to be completed in FY04
201	HCA		Willow Beach genetics Assessment	0	0	?								USFWS responsibility to be completed in FY04
202			<b>National Park Service</b>											
203	HCA		Bright Angel Non-Native Fish Removal	167,000	167,000	?								NPS Funds; feasibility study initiated
204	HCA		Tributary Non-native Fish Survey & Removal	0	0	?								NPS Funds; feasibility study initiated
205			<b>TOTAL AMP PROGRAM COSTS FOR OTHER AGENCIES:</b>	<b>207,000</b>	<b>167,000</b>	<b>0</b>								
206														
207			<b>TOTAL AMP PROGRAM COSTS-ALL AGENCIES:</b>	<b>FISCAL YEAR 2004</b>	<b>FISCAL YEAR 2005</b>	<b>FISCAL YEAR 2006</b>								
208				<b>11,663,000</b>	<b>10,827,660</b>	<b>10,694,537</b>								
209														
210			<b>FY2006 Budget Footnotes:</b>											
211			(1) The Logistics NPS Permitting costs are included above the line under BOR AMWG Administrative support (item #5)											
212			(2) CPI adjustment of 2.5% used for FY2006											
213			(3) Cost share is the difference between the USGS full burden rate (37 to 42%) and the DOI customer rate (17%). USGS full burden rate varies between fiscal years; the DOI customer rate has remained steady since FY2003 (when enacted) at 15%. An additional 2% is added in FY06 to cover facilities charges.											
214			(4) The FY 2006 budgets for these "other related projects" will need to be provided by agencies involved in the undertakings											
215			<b>FY2006 Budget Assumptions:</b>											
216			*The budget reflects the confirmed information that the USGS would again approve a special "pass-through" rate of 6% for GCMRC; it has been factored into the budget as accurately as is feasible at this time.											
217			*Budget based on the assumption that BOR contributes \$200K for TCD, special rate of 6% is applied here											
218			*GCMRC budget based on assumption that the DOI Customer Burden Rate will be 17% and that the USGS Bureau contributes approximately \$1 million for the cost share portion of the burden.											
219			This version of the budget is developed around the option for EXPERIMENTAL TREATMENTS RECOMMENDED FOR IMPLEMENTATION IN FY06, plus implements some reductions to projects and programs in an attempt to meet the target carry-forward of \$750,000 to support experimental work in FY 2007. Indirect costs do not apply to the carry-forward amount until they are expended or obligated in the outyear.											
220			Cells in column A that contain project numbers, such as "A.2", AND are highlighted in light green, indicate that they are proposed and recommended by the GCMRC for funding and implementation in the FY06 workplan											

## APPENDIX B

GCMRC Work Plan ID	ID	FY2006 Project Descriptions	MO	CMINS or INS
<b>U.S. Geological Survey - Biological Resource Division - GCMRC - Power Revenue Funded Projects</b>				

<b>A</b>	<b>Physical Sciences, Modeling &amp; DASA</b>			
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	RES	Fine-Sediment Storage - <b>Monitoring</b>	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
		<b>DASA Activities</b>		
A.4	DASA	Air-Remote Sensing - <b>Monitoring</b>	Goal 12	CMIN 8.5.1?
A.5a	DASA	Data Base Management System	Goal 12	
A.5b	DASA	Data Conversion & Library Support	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>B</b>	<b>BioSciences Program Aquatic &amp; Terrestrial Ecosystem Activities</b>			
B.1	RES	Kanab Ambersnail & SWWF - <b>Monitoring</b>	5.1, 5.2, 6.6, 6.7	CMIN 5.1.1, 5.2.1, 6.7.1
B.2	RES	Aquatic Food base - <b>Monitoring</b>	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 - <b>Monitoring</b>	Goal 2 & MO's 2.1., 2.2, 2.3, 2.4 & Goal 4 & MO 4.2	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 - <b>Monitoring</b>	Goal 4 & MO 4.1	CMIN 4.1.1-4.1.5, 4.1.7
<del>B.5</del>	HCA	Concurrent LCR, Mainstem HBC Pop Est.	Goal 2	
B.5	RES	Habitat Map & Inventory	Goal 6 (MO's 6.1-6.5)	
B.6	EXP	Spawning Redds & Suppression Mechanisms	Goals 2 & 4	
B.7	EXP	Mechanical Removal of Non-native Fish	Goal 2 (MO's 2.1, 2.4, 4.2) & Goal 4	
B.8	HCA	Translocation of Humpback Chub	Goal 2	
B.9	HCA	Dam Operations Experiment	Goal 2	
B.10	HCA	Monitoring Parasites & Diseases	Goal 2	
B.11	HCA	Temperature Control Device	Goal 2 MO's	

<b>GCMRC Work Plan ID</b>	<b>ID</b>	<b>FY2006 Project Descriptions</b>	<b>MO</b>	<b>CMINS or INS</b>
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<b>C Sociocultural Program</b>				
<b>C.1</b>	CM&RES	Integrated Archaeological Site Monitoring	11.1	CMINS 11.1.1., 11.1.2., 11.1.3a, 11.1.4, 11.2.1
<b>C.2</b>	RES	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
<b>C.3</b>	RES	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

<b>D Logistics Support</b>				
<b>D.1</b>	L&S	Logistics (Dispersed throughout projects)		
<b>D.2</b>	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	
<b>D.3</b>	L&S	Control Network	6.4, 7.3, 8.1-8.5, 9.3, 11.1, 12.2, 12.3, 12.9	

<b>E Information Technology Support</b>				
<b>E.1</b>	IT	Systems Administration	All MO's	

<b>F Admin. &amp; Tech. Supp. Services - Administrative &amp; Management</b>				
<b>F.1</b>	ADM	Administrative Operations <sup>(1)</sup>	All MO's	
<b>F.2</b>	ADM	Program Planning & Management	All MO's	
<b>F.3</b>	ADM	TWG/AMWG Participation	All MO's	
<b>F.4</b>	ADM	Independent Reviews	All MO's	
<b>F.5</b>	ADM	Strategic Science Planning	Goal 12 & All MO's	
<b>F.6</b>	ADM	GCMRC Science Symposium	Goal 12 & All MO's	
<b>F.7</b>	ADM	Experimental Fund	Goal 12 & All MO's	
<b>F.8</b>	ADM	AMWG and TWG Requests	Goal 12 & All MO's	

<b>U.S. Geological Survey - Biological Resource Division - GCMRC - NON-Power Revenue Funded Projects</b>				
<b>A Lake Powell Water Quality</b>				
<b>A.1</b>	CM	Lake Powell <b>Monitoring</b>	7.1, 7.2, 7.3	CMIN 7.3.1
<b>B.11</b>	HCA	Temperature Control Device (TCD)	Goals 2 & 4	Native & Non Fish RIN's

AMP DRAFT BUDGET FY2006		C	D	E	F	G	H	I	J	K	L	M	N
ID	Project Descriptions	BOR Approved FY04 Budget	BOR Approved FY05 Budget	BOR Draft FY06 Budget	Comments								
<b>Reclamation Administration Power Revenue Funded Projects</b>													
<b>A</b>	<b>Adaptive Management Work Group</b>												
1	Personnel Costs	151,000	155,530	159,418									
2	AMWG Member Travel Reimbursement	13,000	13,390	15,725									
3	Reclamation Travel	18,000	15,540	13,000									
4	Facilitation Contract	21,000	21,000	25,000									
5	Other	9,000	7,000	7,175									
<b>BOR AMWG Subtotal</b>		<b>212,000</b>	<b>212,460</b>	<b>220,318</b>									
<b>B</b>	<b>Technical Work Group</b>												
1	Personnel Costs	69,000	71,070	72,847									
2	TWG Member Travel Reimbursement	15,000	15,450	20,836									
3	Reclamation Travel	17,000	15,510	15,898									
4	TWG Chair Reimbursement	21,000	21,630	22,171									
5	Other	2,000	2,000	2,050									
<b>TWG Subtotal</b>		<b>124,000</b>	<b>125,660</b>	<b>133,801</b>									
<b>C</b>	<b>Other</b>												
1	Compliance Documents	26,000	26,780	22,450									
2	Administrative Support for NPS Permitting <sup>(1)</sup>			100,000	This administrative cost formerly appeared in the science budget. BAHG resolved on 5/31/05 that this administrative cost be moved to above the science line.								
3	Contract Administration	25,000	25,750	24,394									
<b>Other Subtotal</b>		<b>51,000</b>	<b>52,530</b>	<b>146,844</b>									
<b>D.</b>	<b>Public Outreach</b>	<b>85,000</b>	<b>50,000</b>	-	Moved from USGS in FY05 & 06; Ad Hoc formed 1/7/04 to develop program in FY04; HBC included..								
<b>E.</b>	<b>Development of an LCR Management Plan</b>	<b>0</b>	<b>100,000</b>	<b>0</b>	BOR: Plan to cover Biological Opinion responsibilities								
<b>Reclamation Administrative Subtotal</b>		<b>472,000</b>	<b>540,650</b>	<b>500,964</b>									
<b>F. Programmatic Agreement Cultural Resources</b>													
1	Reclamation Administration	43,000	51,500	52,788									
2	NPS-GRCA Monitoring Costs	200,000	206,000	-	FY06 Moved under GCMRC Cultural Monitoring budget								
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.								
4	NN & GLCA Treatment Plan and Implementation	100,000	100,000	20,000	Should be completed with 20K in FY06								
5	Canyon Treatment Plan and Implementation	0	250,000	250,000									
6	Zuni Conservation Program Mitigation	0	10,000	-	Covered under treatment								
7	TCP GIS Documentation	0	30,000	-									
<b>PA Subtotal</b>		<b>371,000</b>	<b>676,340</b>	<b>322,788</b>									
<b>Reclamation Power Revenue Program Subtotal</b>		<b>843,000</b>	<b>1,216,990</b>	<b>823,752</b>									
<b>Reclamation Administration NON-Power Revenue Funded Projects</b>													
<b>G. Tribal Consultation</b>													
<b>Cooperative Agreements with Tribes</b>													
1	Hopi Tribe	80,000	80,000	97,850	TWG requests more info on products. Also, no dedicated funding for river trips, but they may be supported from these funds if need is specified								
2	Hualapai Tribe	80,000	80,000	97,850	TWG requests more info on products. Also, no dedicated funding for river trips, but they may be supported from these funds if need is specified								
3	Navajo Nation	80,000	80,000	97,850	TWG requests more info on products. Also, no dedicated funding for river trips, but they may be supported from these funds if need is specified								
4	Pueblo of Zuni	80,000	80,000	97,850	TWG requests more info on products. Also, no dedicated funding for river trips, but they may be supported from these funds if need is specified								
5	Southern Paiute	80,000	80,000	97,850	TWG requests more info on products. Also, no dedicated funding for river trips, but they may be supported from these funds if need is specified								
<b>Tribal Consultation Subtotal</b>		<b>400,000</b>	<b>400,000</b>	<b>489,250</b>									
<b>River Trips for Consultation and DOEs</b>													
1	Hopi Tribe	0	15,000	-	See comments above								
2	Hualapai Tribe	0	15,000	-	See comments above								
3	Navajo Nation	0	15,000	-	See comments above								
4	Pueblo of Zuni	0	15,000	-	See comments above								
5	Southern Paiute	0	15,000	-	See comments above								
<b>Tribal River Trip Subtotal</b>		<b>0</b>	<b>75,000</b>	<b>0</b>									
<b>Tribal Subtotal</b>		<b>400,000</b>	<b>475,000</b>	<b>489,250</b>									
<b>Reclamation NON-Power Revenue Subtotal</b>		<b>400,000</b>	<b>475,000</b>	<b>489,250</b>									
<b>BUREAU OF RECLAMATION TOTAL AMP PROGRAM COSTS:</b>		<b>1,243,000</b>	<b>1,691,990</b>	<b>1,313,002</b>									

AMP DRAFT BUDGET FY2006													Revised Date: 07/26/2005	
FY06-No Experiments with 6% and 17% burden applied														
GCMRC Work Plan ID	ID	Project Descriptions	Approved FY04 Budget	Approved FY05 Budget	Outside GCMRC Science/Labor	Logistics Field Support	Project Related Trvl/Training	Operations / Supplies	GCMRC Salaries	Project Subtotal (w/o Burden)	DOI Customer Burden (6 or 17%)	DRAFT FY06 Budget - Gross (inc. Burden)	Comments	
U.S. Geological Survey - Biological Resource Division - GCMRC - Power Revenue Funded Projects														
<b>A Physical Sciences, Modeling &amp; DASA</b>														
63	A.2	CM Integrated Downstream Water Quality Monitoring	179,000	250,000	500,000	75,000	15,000	70,000	309,100	969,100	164,747	1,133,847	Combines A.1b and c from FY05, total reduced below the level requested by AZ District, but work is proposed to be covered by GCMRC staff	
64	A.3	CM Fine-Sediment Storage - Monitoring	549,000	250,000	256,250	-	-	-	-	256,250	15,375	271,625	Support for USU and NAU scientists; close-out year reporting by Fine-sediment Research & Development	
65		CM Streamflow & SS Transport - Monitoring	505,000	500,000	-	-	-	-	-	-	-	-	Work formerly conducted in this project under the FY 2005 annual workplan is now included in project A.2 (above)	
66		EXP SS Mass Balance - Exp. Support	420,000	137,500	-	-	-	-	-	-	-	-	No additional suspended-sediment work is scheduled in support of High-flow Test research in WY 2006	
67		RES Nutrient Flux - Res. Toward Core Mon.	0	0	-	-	-	-	-	-	-	-	Work on this topic during FY06, is included in new food web research described in project B.2	
68		RES SS Transport Modeling	231,000	0	-	-	-	-	-	-	-	-	Research project was completed in FY 2005, and ongoing verification of the sand-transport algorithm is planned within project A.2	
69		CM Coarse-Grained Inputs - Monitoring	135,000	0	-	-	-	-	-	-	-	-	Project is recommended to be conducted on a biennial schedule (next in FY 2007) with focus on use of remotely sensed imagery data	
70		EXP Coarse Sediment - Debris-Fan Reworking	49,000	0	-	-	-	-	-	-	-	-	No additional coarse-sediment work is scheduled in support of High-flow Test research in WY 2006	
71		EXP Fine-Sediment Storage - Extra EXP. Elements	500,000	750,000	-	-	-	-	-	-	-	-	No additional fine-sediment storage work is scheduled in support of High-flow Test research in WY 2006	
72		EXP Fine-Sediment - Sand Deposition in Arroyos	25,000	0	-	-	-	-	-	-	-	-	No additional fine-sediment storage work is scheduled in support of High-flow Test research in WY 2006	
73		EXP Fine-Sediment - Camping Beach Changes	25,000	0	-	-	-	-	-	-	-	-	No additional fine-sediment storage work is scheduled in support of High-flow Test research in WY 2006	
74		EXP SS Transport Modeling - Sand Routing Exps.	62,000	0	-	-	-	-	-	-	-	-	No additional suspended-sediment work is scheduled in support of High-flow Test research in WY 2006	
75		<b>Physical Sciences Subtotal</b>	<b>2,680,000</b>	<b>1,887,500</b>	<b>756,250</b>	<b>75,000</b>	<b>15,000</b>	<b>70,000</b>	<b>309,100</b>	<b>1,225,350</b>	<b>180,122</b>	<b>1,405,472</b>		
<b>DASA Activities</b>														
78	A.4	DASA Air-Remote Sensing - Monitoring	163,000	200,000	-	-	-	-	28,100	28,100	4,777	32,877	No additional data acquisition is schedule for FY06, only post-processing and analysis of data collected in FY 2005 and earlier	
79	A.5a	DASA Data Base Management System	128,000	128,000	32,500	-	3,000	12,000	91,500	139,000	18,105	157,105	Continued design and implementation of the Oracle database in support of science and information activities	
80	A.5b	DASA Library & Scanning Data Conversion Project	79,000	99,000	24,000	-	4,000	29,250	88,600	145,850	22,155	168,005	Library (including imagery data conversion project) re-organized as a part of the DASA in FY06	
81	A.6	DASA GIS: GIS General Support for Integrated Analyses & Projects	160,000	160,000	18,200	-	5,000	15,000	122,500	160,700	25,317	186,017	Continued support of science and information activities	
82	A.7	DASA Channel Mapping	90,000	0	-	-	-	-	28,100	28,100	4,777	32,877	Portion of Remote Sensing Coordinator's time shall be devoted to completion of mosaicing of channel mapping data	
83		<b>DASA Subtotal</b>	<b>620,000</b>	<b>587,000</b>	<b>74,700</b>	<b>0</b>	<b>12,000</b>	<b>56,250</b>	<b>358,800</b>	<b>501,750</b>	<b>75,131</b>	<b>576,881</b>		
84		<b>Physical Sciences, Modeling &amp; DASA Subtotal</b>	<b>3,300,000</b>	<b>2,474,500</b>	<b>830,950</b>	<b>75,000</b>	<b>27,000</b>	<b>126,250</b>	<b>667,900</b>	<b>1,727,100</b>	<b>255,253</b>	<b>1,982,353</b>		
<b>B BioSciences Program</b>														
<b>Aquatic &amp; Terrestrial Ecosystem Activities</b>														
88	B.1	CM Kanab Ambersnail & SWWF - Monitoring	79,000	79,000	55,000	40,000	5,000	-	14,215	114,215	9,617	123,832	Compliance Monitoring for terrestrial species (KAS & SWWF)	
89	B.2	CM Aquatic Foodbase - Monitoring	248,000	315,000	100,000	85,000	5,000	-	109,015	299,015	35,055	334,070	FY06 budget placeholder: project scope and design need shall determine whether these funds are available for other purposes in FY06	
90	B.3	CM Status & Trends of DS Fish - Monitoring	870,000	820,000	550,000	130,000	5,000	20,000	135,465	840,465	82,379	922,844	Continuation of work with emphasis on need to evaluate sampling approaches for both abundance & distribution	
91	B.4	CM Status & Trends LF Trout - Monitoring	161,000	111,000	90,000	8,000	-	-	44,215	142,215	14,277	156,492	Continuation of work with emphasis on need to evaluate sampling approaches for both abundance & distribution	
92		CM Terrestrial Ecosystem - Monitoring	505,000	300,000	-	-	-	-	-	-	-	-	Non-activity year for this project with recommendation to resume activities on a biennial basis in FY 2007	
93	B.5	CM Habitat Map & Inventory -Monitoring	48,000	0	-	-	-	-	14,215	14,215	2,417	16,632	Portion of Terrestrial Biologist salary devoted to completion of vegetation mapping project	
94		EXP Primary Productivity, Carbon Flux	59,000	0	-	-	-	-	-	-	-	-	Work on this topic during FY06, is included in new food web research described in project B.2	
95		EXP Temperatures and Habitat Use Monitoring	200,000	150,000	-	-	-	-	-	-	-	-	see BOR brief on program changes	
96		EXP Kanab Ambersnail Population EHF Impacts	10,000	10,000	-	-	-	-	-	-	-	-	No additional work is scheduled in support of High-flow Test research in WY 2006	
97		EXP Foodbase Impacts of EHF Flows	50,000	0	-	-	-	-	-	-	-	-	No additional work is scheduled in support of High-flow Test research in WY 2006	
98	B.7	EXP Spawning Redds & Suppression Mechanisms	175,000	0	-	-	-	-	-	-	-	-	Recommendation to replicate (under a return to MLFF) field studies conducted in support of EFF in 2003-04 (model verification), NOT IMPLEMENTED UNDER NON-EXPERIMENTAL VERSION	
99		EXP Food Base Impacts of Fluctuating Flows	60,000	0	-	-	-	-	-	-	-	-	Work on this topic during FY06, is included in new food web research described in project B.2 (return to MLFF is recommended in FY06)	
100	B.6	EXP Mechanical Removal of Non-native Fish	586,000	586,000	-	-	-	-	-	-	-	-	Recommendation to continue this experimental treatment through its fourth year as originally proposed by GCMRC in 2002 EXP plan, NOT IMPLEMENTED UNDER NON-EXPERIMENTAL VERSION	
101		EXP Rainbow Diet Analysis & Predation of Chubs	50,000	50,000	-	-	-	-	-	-	-	-	\$50K added (1/8/2004)	
102	B.6	HCA Translocation of Humpback Chub	25,000	50,000	45,000	5,000	-	-	-	50,000	3,550	53,550	As recommended by the HBCCP ad hoc, this effort is continued by USFWS (Chute Falls project) for a fifth year with evaluation	
103	B.7	HCA Dam Operations Experiment	50,000	50,000	15,000	-	10,000	-	-	25,000	2,600	27,600	HBCCP recommendation - restore 25K to Dam Ops Planning (experimental planning support)	
104		HCA Scientific, Recreation Impact Assessment	11,000	30,000	-	-	-	-	-	-	-	-	Project results available in FY 2005-06	
105		HCA Fish Monitoring below Diamond Creek	50,000	50,000	-	-	-	-	-	-	-	-	TWG motion passes at June 2005 meeting supports doing this work in 2006, contingent upon certain criteria	
106	B.8	HCA Monitoring Parasites and Diseases	50,000	55,000	-	20,000	-	-	-	20,000	3,400	23,400	GCMRC shall continue supporting completion of this work in FY06. Initial funds were provided in FY 2005 to implement project	
107	B.5	HCA Concurrent LCR, Mainstem HBC Pop Est.	250,000	200,000	-	-	-	-	-	-	-	-	Recommendation - BAHG "Defer to FY 2007" GCMRC concurs with this recommendation	
108		HCA HBC Outreach	0	0	-	-	-	-	-	-	-	-	Combined with AMWG outreach (see Project E.5)	
109		HCA Genetics Management Plan	0	0	-	-	-	-	-	-	-	-	USFWS, written by Region 6 (draft was distributed in spring 2005)	
110		HCA Sediment, Turbidity Augmentation	50,000	25,000	-	-	-	-	-	-	-	-	\$25K added (1/8/04); vote 14=yes, 4=no, 0=ab; Project scheduled for completion in FY06, proposal on file with GCMRC	
111		HCA Sediment Augmentation Feasibility Study	0	50,000	-	-	-	-	-	-	-	-	\$50K added (1/8/04); vote 9=yes, 7=no, 1=ab; Project scheduled for completion in FY06, proposal on file with GCMRC	
112		HCA HBC Genetics Evaluation	0	0	-	-	-	-	-	-	-	-	Funded in FY01; contracted through GCMRC; final report by cooperators to AMWG due by January of 2006	
113		HCA Feasibility of HBC Augmentation	0	0	-	-	-	-	-	-	-	-	Funded prior to FY04; Project final report completed by USFWS in 2004, report available through the GCMRC's electronic library	
114		<b>BioSciences Subtotal</b>	<b>3,587,000</b>	<b>2,931,000</b>	<b>855,000</b>	<b>288,000</b>	<b>25,000</b>	<b>20,000</b>	<b>317,125</b>	<b>1,505,125</b>	<b>153,295</b>	<b>1,658,420</b>		

AMP DRAFT BUDGET FY2006													Revised Date: 07/26/2005
GCMRC Work Plan ID	ID	Project Descriptions	Approved FY04 Budget	Approved FY05 Budget	Outside GCMRC Science/Labor	Logistics Field Support	Project Related Trvl/Training	Operations / Supplies	GCMRC Salaries	Project Subtotal (w/o Burden)	DOI Customer Burden (6 or 17%)	DRAFT FY06 Budget - Gross (inc. Burden)	Comments
59													
115													
116	C	Sociocultural Program											
117	CM	Eval. & Plan for Cultural - Monitoring	0	0	-	-	-	-	-	-	-	-	-
118	RES	1st Yr Geomorph. Model, Process Study	0	135,000	-	-	-	-	-	-	-	-	-
119	RES	Implementation of Recreation PEP recommendations	0	40,000	-	-	-	-	-	-	-	-	-
120	RES	Implementation of Socioeconomic PEP recommendations	0	40,000	-	-	-	-	-	-	-	-	-
121	EXP	Tribal Funding for Experimental Flows	0	25,000	-	-	-	-	-	-	-	-	-
122	RES	Tribal Outreach Workshop (Tribal Training/Integration)	45,000	0	-	-	-	-	-	-	-	-	-
123	RES	APE Study	25,000	0	-	-	-	-	-	-	-	-	-
124	C.1	CM Integrated Archaeological Site Monitoring	0	0	234,420	70,000	-	5,000	32,450	341,870	32,331	374,201	Support for ongoing monitoring activities, with some additional support for involvement by GCMRC staff and cooperators and cooperators
125	C.2	CM Integrated Tribal Values Monitoring	0	0	50,000	-	-	-	25,000	75,000	7,250	82,250	Start up and pilot program for tribal monitoring planning efforts during FY 2006, with potentially increased activity in FY 2006 and beyond; scope of work and budget were recommended to be revised by TWG as per motion passed at the June meeting
126	C.3	CM Integrated Campsite Monitoring Program	0	0	50,000	15,000	-	6,000	7,450	78,450	7,837	86,287	Start up and pilot program for campsite monitoring efforts during FY06, with potentially increased activity in FY 2007 and beyond
127		Sociocultural Program Subtotal	70,000	240,000	334,420	85,000	0	11,000	64,900	495,320	47,418	542,738	
128													
129	D	Logistics Support											
130	D.1	L&S Logistics (Dispersed throughout projects)						100,000	62,800	162,800	27,676	190,476	Additional funds needed to refurbish and replace river equipment prior to Phase II experimentation
131	D.2	L&S Survey Operations	126,000	126,000	28,150	35,000	-	-	64,900	128,050	18,672	146,722	Ongoing field and office support for science projects and control network development (see D.3)
132	EXP	Technical Support - Survey Equipment	32,000	32,000	-	-	-	-	-	-	-	-	No additional work is scheduled in support of High-flow Test research in WY 2006
133	D.3	L&S Control Network	86,000	150,000	51,150	35,000	-	-	66,000	152,150	20,239	172,389	Ongoing support for development of the Canyon-wide control network
134		Logistics Support Subtotal	244,000	308,000	79,300	70,000	0	100,000	193,700	443,000	66,587	509,587	
135													
136	E	Information and Outreach Program											
137	IPO	Web page and product development	-	75,000	-	-	-	-	-	-	-	-	-
138	E.1	IPO GCMRC Component of SBSC Sys Admin Support	242,000	242,000	-	-	5,000	165,000	133,000	303,000	51,510	354,510	75% of GS-12 and 100% of GS-9 IT positions in support of system administration at the GCMRC FY06. GS-7 IT position covered by SBSC
139	EXP	Systems Administration & Computer Technical Support	21,000	21,000	-	-	-	-	-	-	-	-	-
140		Information Office Subtotal	263,000	338,000	0	0	5,000	165,000	133,000	303,000	51,510	354,510	No additional work is scheduled in support of High-flow Test research in WY 2006
141													
142		Admin. & Tech. Supp. Services											
143	F	Administrative & Management											
144	F.1	ADM Administrative Operations <sup>1)</sup>	620,000	638,600	15,000	-	40,795	314,500	290,000	660,295	112,250	772,545	Includes full-time GS-15 salary for the GCMRC Chief's position, plus moving costs for new Chief to Flagstaff
145	F.4	EXP Administrative Support	5,000	5,000	-	-	-	-	-	-	-	-	-
146	F.2	ADM Program Planning & Management	274,000	282,220	-	-	15,000	12,130	458,200	485,330	82,506	567,836	Full-time salaries for Physical, Biological, Cultural, Logistics program managers and 75% for Information Officer
147	F.3	ADM TWG/AMWG Participation	45,000	46,350	-	-	15,000	-	-	15,000	2,550	17,550	Travel support only
148	F.4	ADM Independent Reviews	222,000	272,000	325,000	-	-	-	-	325,000	55,250	380,250	Additional support required to support additional strategic planning efforts in FY06.
149	F.5	TBD GCMRC's additional Strategic Planning Support			25,000	-	-	-	-	25,000	4,250	29,250	Additional support required to support additional strategic planning efforts in FY06.
150	F.6	TBD GCMRC Science Symposium			25,000	-	-	-	-	25,000	4,250	29,250	Required support for the October 2005 Biennial Science Symposium in Tempe, AZ
151	F.7	EXP Projected FY06 Carry Forward for Experiment Phase II			1,030,500	-	-	-	-	1,030,500	-	1,030,500	Projected FY06 carry forward to support EXP Phase II treatments in FY 2007-08 (cost share and burden not required until FY 2007)
152	ADM	Public Outreach (Moved to BOR)	0	0	-	-	-	-	-	-	-	-	-
153	F.8	AMP AMWG, TWG Requests	0	73,000	75,000	-	-	-	-	75,000	12,750	87,750	A: Moved to BOR in FY2006; Hoc formed 1/7/04 to develop program in FY04; HBC included
154	AMP	Unsolicited Proposals (Other research activities)	0	50,000	-	-	-	-	-	-	-	-	-
155		Administrative & Management Subtotal	1,166,000	1,367,170	1,495,500	-	70,795	326,630	748,200	2,641,125	273,806	2,914,931	
156		Logistics, Info Office & Admin Support Subtotal	1,673,000	2,013,170	1,574,800	70,000	75,795	591,630	1,074,900	3,387,125	391,903	3,779,028	
157		GCMRC Power Revenue Subtotal	8,630,000	7,658,670	3,595,170	518,000	127,795	748,880	2,124,825	7,114,670	847,869	7,962,539	
158													
159		U.S. Geological Survey - Biological Resource Division - GCMRC - NON-Power Revenue Funded Projects											
160	A	Lake Powell											
161	A.1	CM Lake Powell Monitoring	210,000	210,000	-	-	10,000	38,924	138,250	187,174	31,820	218,994	Assumes BOR pays NPS directly for position (25-35K)
162	B.9	HCA Temperature Control Device (TCD)	200,000	50,000	188,680	-	-	-	-	188,680	11,321	200,001	GCMRC prepared a workplan and budget in collaboration with BuRec during spring 2005, report on this work will be made at June 2005 TWG.
163	RES	Kanab Ambersnail Taxonomy (USGS Appr. Only)	88,000	0	-	-	-	-	-	-	-	-	-
164		GCMRC NON-Power Revenue Funded Project Subtotal	498,000	260,000	188,680	0	10,000	38,924	138,250	375,854	43,140	418,994	Implemented with USGS appropriations in FY04 only
165													
166		GCMRC TOTAL AMP PROGRAM COSTS:	9,128,000	7,918,670	3,783,850	518,000	137,795	787,804	2,263,075	7,490,524	891,009	8,381,533	

AMP DRAFT BUDGET FY2006	C	D	E	F	G	H	I	J	K	L	M	N	
GCMRC Work Plan ID	ID	Project Descriptions	Approved FY04 Budget	Approved FY05 Budget	Outside GCMRC Science/Labor	Logistics Field Support	Project Related Trvl/Training	Operations / Supplies	GCMRC Salaries	Project Subtotal (w/o Burden)	DOI Customer Burden (6 or 17%)	DRAFT FY06 Budget - Gross (inc. Burden)	Comments

BOR & USGS-GCMRC AMP PROGRAM COSTS			FISCAL YEAR 2004	FISCAL YEAR 2005	FISCAL YEAR 2006
BOR Power Revenue Program Costs			843,000	1,216,990	823,752
GCMRC Power Revenue Program Costs (net)			7,578,261	6,703,191	7,114,670
GCMRC DOI Customer Burden (Indirect Costs)			1,136,739	1,005,479	847,869
<b>Subtotal BOR &amp; GCMRC Power Revenue Program Costs</b>			<b>9,558,000</b>	<b>8,925,660</b>	<b>8,786,290</b>
BOR Non-Power Revenue Program Costs			400,000	475,000	489,250
GCMRC Non-Power Revenue Program Costs			498,000	260,000	375,854
GCMRC DOI Customer Burden (Indirect Costs)			0	0	43,140
<b>Subtotal BOR &amp; GCMRC Non-Power Revenue Program Costs</b>			<b>898,000</b>	<b>735,000</b>	<b>908,244</b>
Estimated Cost Share expense required by USGS policy <sup>(3)</sup>			1,000,000	1,000,000	1,000,000
<b>TOTAL AMP PROGRAM COSTS (BOR &amp; GCMRC):</b>			<b>11,456,000</b>	<b>10,660,660</b>	<b>10,694,535</b>

FUNDING:	FY 2004	FY 2005	FY06(2)
USBR & USGS Power Revenues under cap	8,363,000	8,572,000	8,786,300
FY04 Carry Over	0	0	0
<b>FY05 Previously Unidentified Funds (EHF)</b>	<b>0</b>	<b>848,000</b>	<b>0</b>
USGS Appropriations <sup>(3)</sup>	1,100,000	1,000,000	1,097,375
USBR Appropriations <sup>(4)</sup>	295,000	295,000	297,375
NPS Funds <sup>(5)</sup>	167,000	167,000	0
NPS Appropriations <sup>(3)</sup>	95,000	95,000	97,850
FWS Appropriations <sup>(3)</sup>	95,000	95,000	97,850
BIA Appropriations <sup>(3)</sup>	95,000	95,000	97,850
BOR Operations & Maintenance (IQWP)	210,000	210,000	218,994
USGS Funds for Remote Sensing	180,000	0	0
<b>TOTAL AVAILABLE FUNDS</b>	<b>10,600,000</b>	<b>11,377,000</b>	<b>10,693,594</b>
<b>TOTAL FUNDING NEEDED</b>	<b>11,663,000</b>	<b>10,827,660</b>	<b>10,694,535</b>
<b>SUB-TOTAL AVAILABLE FUNDS - ESTIMATED COSTS</b>	<b>(1,063,000)</b>	<b>549,340</b>	<b>(941)</b>
Experimental High Flows Testing - 11/2004	0	549,340	0
<b>TOTAL AVAILABLE FUNDS - ESTIMATED COSTS</b>	<b>(1,063,000)</b>	<b>0</b>	<b>(949)</b>

OTHER RELATED PROJECTS <sup>4</sup>			FISCAL YEAR 2004	FISCAL YEAR 2005	FISCAL YEAR 2006
<b>US Fish &amp; Wildlife Service</b>					
HCA	HBC Captive Breeding/Refugia		40,000	0	?
HCA	Willow Beach genetics Assessment		0	0	?
<b>National Park Service</b>					
HCA	Bright Angel Non_Native Fish Removal		167,000	167,000	?
HCA	Tributary Non-native Fish Survey & Removal		0	0	?
<b>TOTAL AMP PROGRAM COSTS FOR OTHER AGENCIES:</b>			<b>207,000</b>	<b>167,000</b>	<b>0</b>

TOTAL AMP PROGRAM COSTS - ALL AGENCIES:	FISCAL YEAR 2004	FISCAL YEAR 2005	FISCAL YEAR 2006
	11,663,000	10,827,660	10,694,535

**FY2006 Budget Footnotes:**

(1) The Logistics NPS Permitting costs are included above the line under BOR AMWG Administrative support (item #5)

(2) CPI adjustment of 2.5% used for FY2006

(3) Cost share is the difference between the USGS full burden rate (37 to 42%) and the DOI customer rate (17%). USGS full burden rate varies between fiscal years; the DOI customer rate has remained steady since FY2003 (when enacted) at 15%. An additional 2% is added in FY06 to cover facilities charges.

(4) The FY 2006 budgets for these "other related projects" will need to be provided by agencies involved in the undertakings

**FY2006 Budget Assumptions:**

\*The budget reflects the confirmed information that the USGS would again approve a special "pass-through" rate of 6% for GCMRC; it has been factored into the budget as accurately as is feasible at this time.

\*Budget based on the assumption that BOR contributes \$200K for TCD, special rate of 6% is applied here

\*GCMRC budget based on assumption that the DOI Customer Burden Rate will be 17% and that the USGS Bureau contributes approximately \$1 million for the cost share portion of the burden.

This version of the budget is developed around the option for NO EXPERIMENTAL TREATMENTS IMPLEMENTED IN FY06

Indirect costs do not apply to the carry-forward amount until they are expended or obligated in the outyear.

Cells in column A that contain project numbers, such as "A.2", AND are highlighted in light green, indicate that they are proposed and recommended by the GCMRC for funding and implementation in the FY06 workplan

**APPENDIX C**  
**(See Supplemental Excel Spreadsheet)**

**FY 2006 BUDGET WITHOUT GCMRC'S EXPERIMENTAL COMPONENTS**

**FY2006 Budget Footnotes: WITHOUT GCMRC's RECOMMENDED EXPERIMENTAL TREATMENTS, BUT WITH RECOMMENDED HUMPBACK CHUB ACTIONS**

- (1) The Logistics NPS Permitting costs are included above the line under BOR AMWG Administrative support (item #5)
- (2) CPI adjustment of 2.5% used for FY2006
- (3) Cost share is the difference between the USGS full burden rate (37 to 42%) and the DOI customer rate (17%). USGS full burden rate varies between fiscal years; the DOI customer rate has remained steady since FY2003 (when enacted) at 15%. An additional 2% is added in FY 2006 to cover facilities charges.
- (4) The FY 2006 budgets for these "other related projects" will need to be provided by agencies involved in the undertakings

**FY2006 Budget Assumptions:**

\*The budget reflects the confirmed information that the USGS would again approve a special "pass-through" rate of 6% for GCMRC; it has been factored into the budget as accurately as is feasible at this time.

\*Budget based on the assumption that BOR contributes \$200K for TCD, special rate of 6% is applied here

\*GCMRC budget based on assumption that the DOI Customer Burden Rate will be 17% and that the USGS Bureau contributes approximately \$1 million for the cost share portion of the burden.

**This version of the budget is developed around the option for NO EXPERIMENTAL TREATMENTS IMPLEMENTED IN FY 2006**

Indirect costs do not apply to the carry-forward amount until they are expended or obligated in the out year.

Cells in column A that contain project numbers, such as "A.2", **AND** are highlighted in **LIGHT GREEN**, indicate that they are proposed and recommended by the GCMRC for funding and implementation in the FY 2006 workplan

## APPENDIX D

### Program Overviews and Resource Status Updates

The GCMRC proposes to operate during FY 2006, under a slightly revised organizational structure focused on the following four program areas, each with a program manager: Physical Science and Data Acquisition, Storage and Analysis (DASA), Biosciences, Cultural Resources, and Logistics & Surveying. In 2006 and beyond, Information Technology needs of the GCMRC (system administration, web page development and maintenance, IT security and off-site data archives, etc.) shall be provided through a more centralized support of the SBSC Information Technologies Director and related IT staff of the overall Science Center. Of the four research stations within the SBSC, the GCMRC is the largest and therefore contributes the greatest amount of funding to the IT Department through a cost-shared approach to getting support needs met for all SBSC scientists and staff.

Additional revisions within the four remaining program areas of the GCMRC shall be identified within the GCMRC's *Strategic Science Implementation Plan* and will be implemented fully starting in FY 2007 and beyond. The intended purpose of these organization changes is to better focus the GCMRC staffing plan on resource and science need priorities identified in the GCD-AMP's Strategic Plan. The GCMRC believes that a more streamlined and re-focused organizational structure within the GCMRC will allow the staff and cooperators to better meet the challenges of integrating monitoring and research activities as stipulated in the GCMRC mission statement (see above), while retaining critical technology support from the larger Southwest Biological Science Center.

Furthermore, the former existence of an Information Technology program within the GCMRC 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

summer 2005, the 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.

An emphasis in the reorganization of the GCMRC programs is focused on meeting critical research needs related to fisheries and related aquatic resources, expanding the range of science related to the Socio-Cultural resource areas, continued experimentation to reduce management uncertainties and establishment of a cost effective long-term monitoring program that can be used by managers and scientists to relate dam operations to changes in downstream resources.

### **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) Development of techniques to inventory 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 (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.

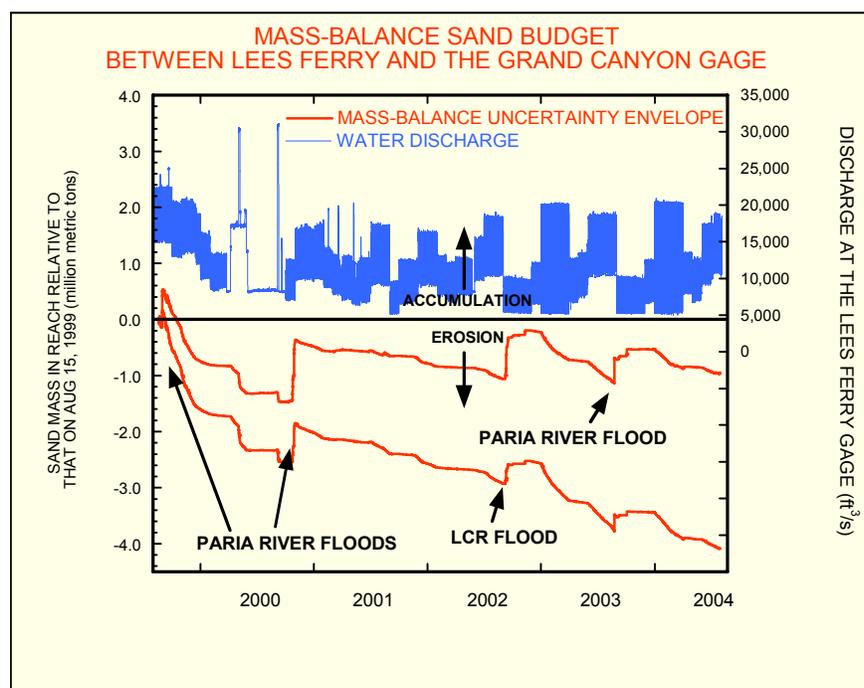


Figure 1.2. Mass-balance of fine sediment between Lees Ferry and Grand Canyon since August 1999 (data are provisional and subject to review and revision).

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.

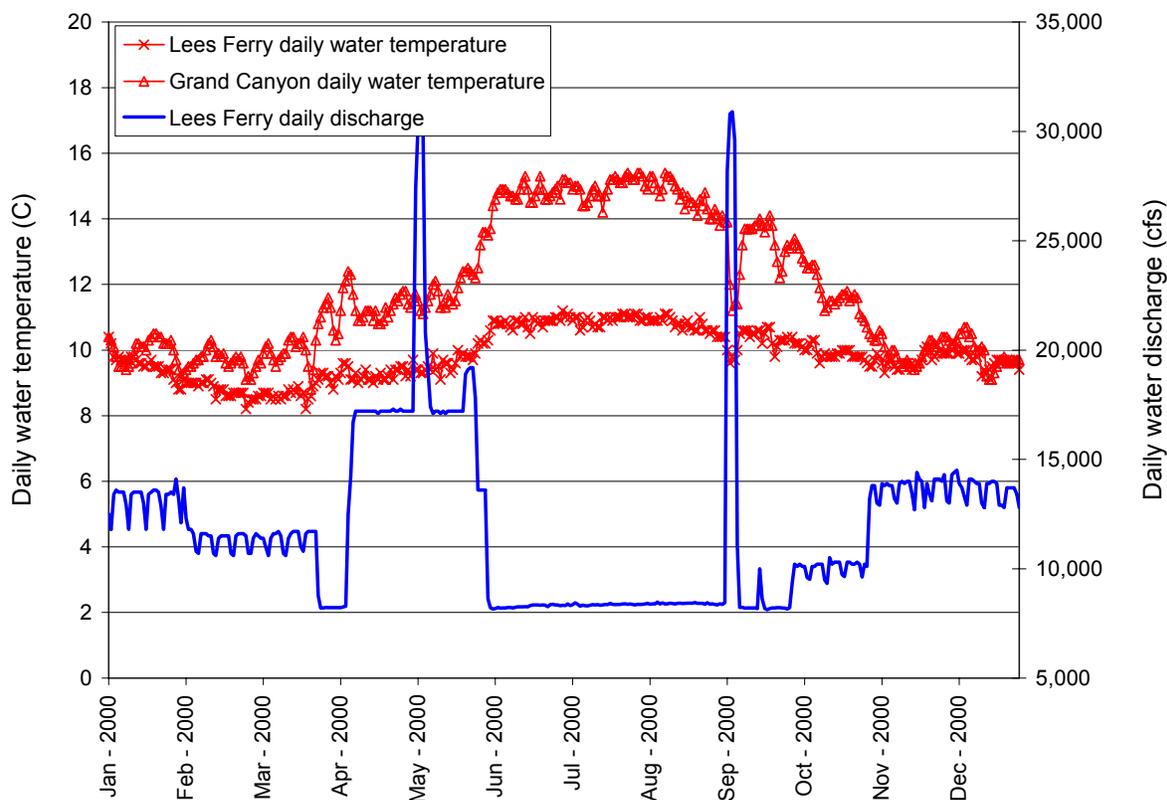


Figure 1.3. Daily water temperature data at Lees Ferry (mile 0) and Grand Canyon gages (mile 87) and daily flows at Lees Ferry during calendar year 2000.

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 High-Flow Testing in November 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 cfs daily 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 20<sup>th</sup> 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 22<sup>nd</sup> at 4 am. The peak was maintained for 60 hours and the flow returned to 8,000 cfs on November 25<sup>th</sup> 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 FY2002-05 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.

FY 2005 Remote-Sensing Activities – In support of the November 2004 High-Flow sediment test, two LiDAR missions were flown (before and after the release) to define high-resolution topographic changes in sand bars within study reaches between Lees Ferry and Phantom Ranch (river miles 0 to 87). These overflights were intended only to provide data on topography changes caused by the test release, but provided no imagery per se. To achieve the goals of capturing imagery of the changes caused by the 2004 test system-wide, as well as document the persistence of any sand bar changes captured in the winter LiDAR overflights, a multi-faceted overflight was planned and implemented approximately six months following the high-flow Test. During the Memorial Day weekend 2005, the GCMRC's contractors successfully accomplished overflights aimed at: 1) system-wide capture of orthorectified, digital, multi-spectral imagery (with automated photogrammetry to define topographic changes at a coarser resolution than achieved with the LiDAR technique) and 2) repeat of LiDAR coverage previously flown immediately before and after the November 2004 High-Flow Test within monitoring reaches between Lees Ferry and Phantom Ranch. Both of these data sets were

collected within the agreed upon timeframe of steady flows planned by BuRec and GCMRC so as to minimize the impact to normal hydropower plant operations. Flows were held at a steady release of 8,000 cfs from the evening of Thursday May 26<sup>th</sup> through the evening of Tuesday May 31<sup>st</sup>. Normal operations commenced on June 1<sup>st</sup> with no impact to the June operating schedule. These data will be extremely valuable in evaluations of the influence of the November 2004 sediment test on downstream sand resources, as well as meet the longer-term monitoring requirements of the science program with respect to assessing changes in the terrestrial environment, including vegetation changes.

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](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.

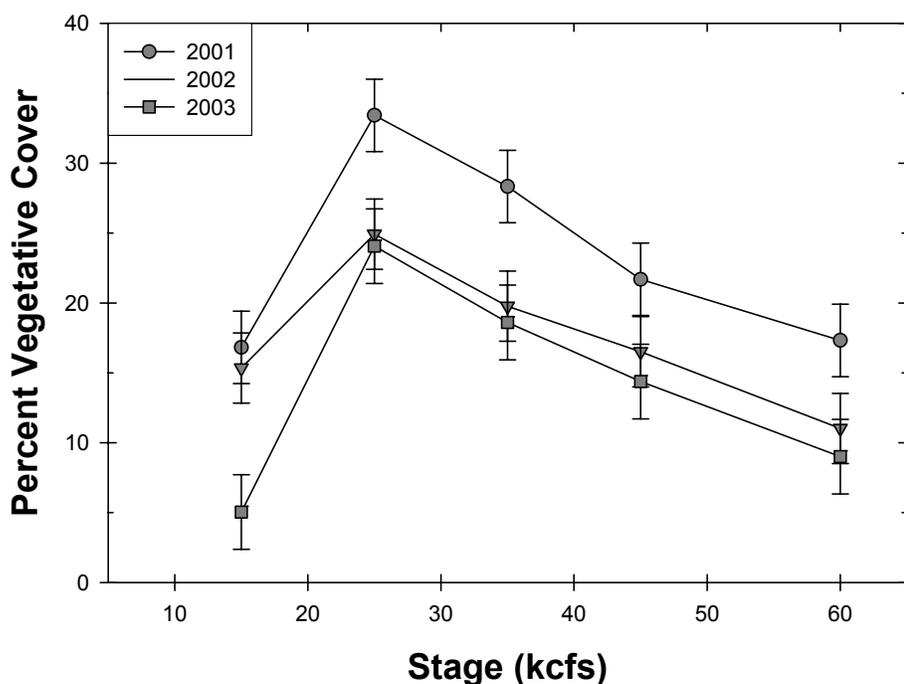


Figure 1.4. Percent vegetative cover at five stage elevation zones between 2001 and 2003. Vertical bars represent +/- 1 standard error. Cover has declined in all zones since 2001. Discharge had the greatest effect on stages from 35k cfs to 15K cfs. Overall vegetation cover within the riparian zone is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

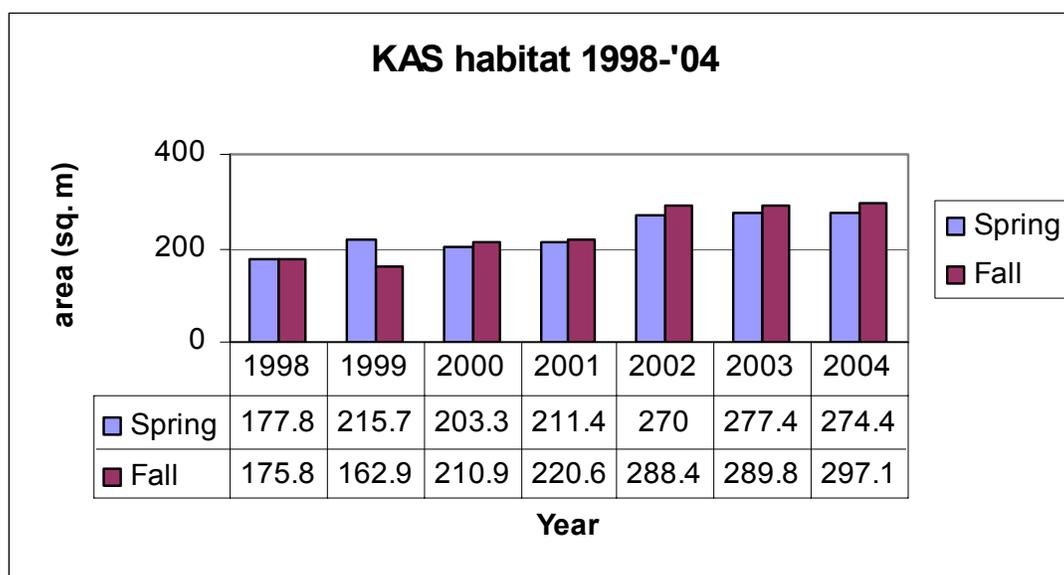
Through FY05 terrestrial monitoring included a yearly field-based assessment of vegetation cover, species richness and diversity at 60 transect sites along the CRE at discharges of 15, 25, 35, 45, and 60k cfs. The intent of these longitudinal transects at set discharges are to link changes in measured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

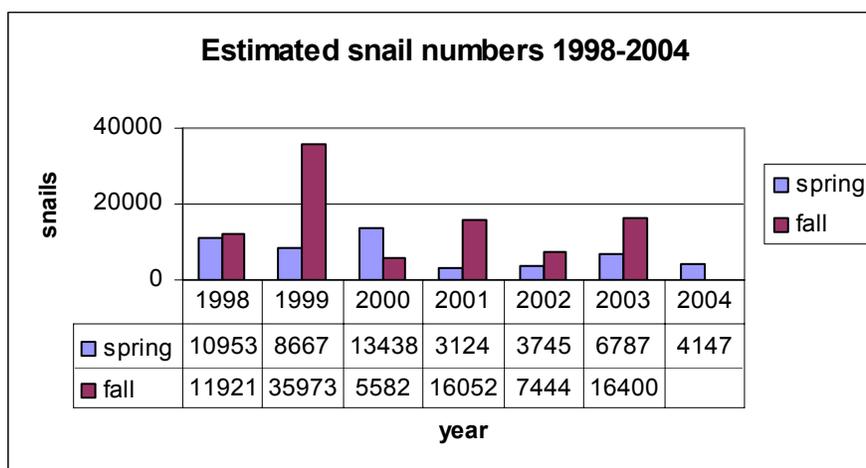
resource availability. Bird abundance and density, which included migrants and permanent winter and summer residents, was greater in the New High Water Zone ( $t=3.4$ ,  $p=0.001$ ) (Yard and Blake, 2002). Species richness was also higher in the New High Water Zone. This was in contrast to 2001 where 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<sup>2</sup> in April to 288.36 m<sup>2</sup> by August 24, 2002.



Yearly average total habitat has increased steadily and significantly since 1998, from 176 m<sup>2</sup> in 1998 to 297 m<sup>2</sup> 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



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 aquatilis* (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.

### **Aquatic Productivity and Food 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 food base 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 food web 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 food web 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). These 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.

### **SBSC's ROLE IN INFORMATION TECHNOLOGY SUPPORT**

The Southwest Biological Science Center's Information Technology and Outreach Department (SBSC-ITOD) was originated as part of the GCMRC in 1998. It served the GCMRC well, but is now expanding to meet the greater needs of other research stations housed within the SBSC. The broad purpose of a more centralized SBSC's ITOD, is to increase awareness of each of the four research station's science activities and products and to facilitate the dissemination of data, information, and products to the SBSC's cooperators, stakeholders, other non-cooperating scientists and the public through web page design, access and support. These groups of end users can be collectively referred to as the SBSC's science constituency.

The SBSC's Information Technology Department objectives will be accomplished through the jointly funded, but SBSC guided, activities focused on increasingly important IT security, general systems administration and ongoing web page and server access development. Systems administration is responsible for providing computer and network infrastructure needed for all SBSC websites, including GCMRC. Systems administration also coordinates the Center's World Wide Web presence via a website on the Internet. Eventually, nearly all of the digital data, information, and products generated by the research stations of the SBSC will be available to our constituency from the SBSC website. Some imagery data sets may not be available through the web sites, owing to sheer size and will be served through delivery of DVD duplicates, tapes, etc. However, most is not all reports will eventually be available in a paperless format through the internet. Such a plan also reduces space costs associated with housing paper reports within a conventional library as future work continues. This plan proposes that future website development be serviced in-house to provide greater flexibility with the changing needs of the GCMRC, as well as the other three research stations. A new full-time Web

development position will be created that will be funded jointly by the GCMRC and the SBSC to serve the overall needs of the science center.

Program implementation, primarily in the area of web development, is expected to continue advancing in FY2004 and continue through FY2006 and beyond to a point where the program may enter a maintenance era 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 SBSC and GCMRC science activities, user needs, and advances in technology.

### **SBSC Website Services**

Aside from direct personal contact through formal and informal meetings with staff, the SBSC website(s) are 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 the GCMRC and other station's mission and projects
- 2) Contact information for all SBSC science and support staff
- 3) Links to other relevant U.S. Geological Survey offices and SBSC 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, GCD-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, such as the DASA, 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 Colorado River ecosystem, including nearly all of the data and digital 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.

### **Systems administration**

The SBSC and GCMRC computing environments are 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 SBSC. 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.

**Web and FTP Services** - The IT Department of the SBSC administers 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.